The UNESCO Courier

A window open on the world

May 1966
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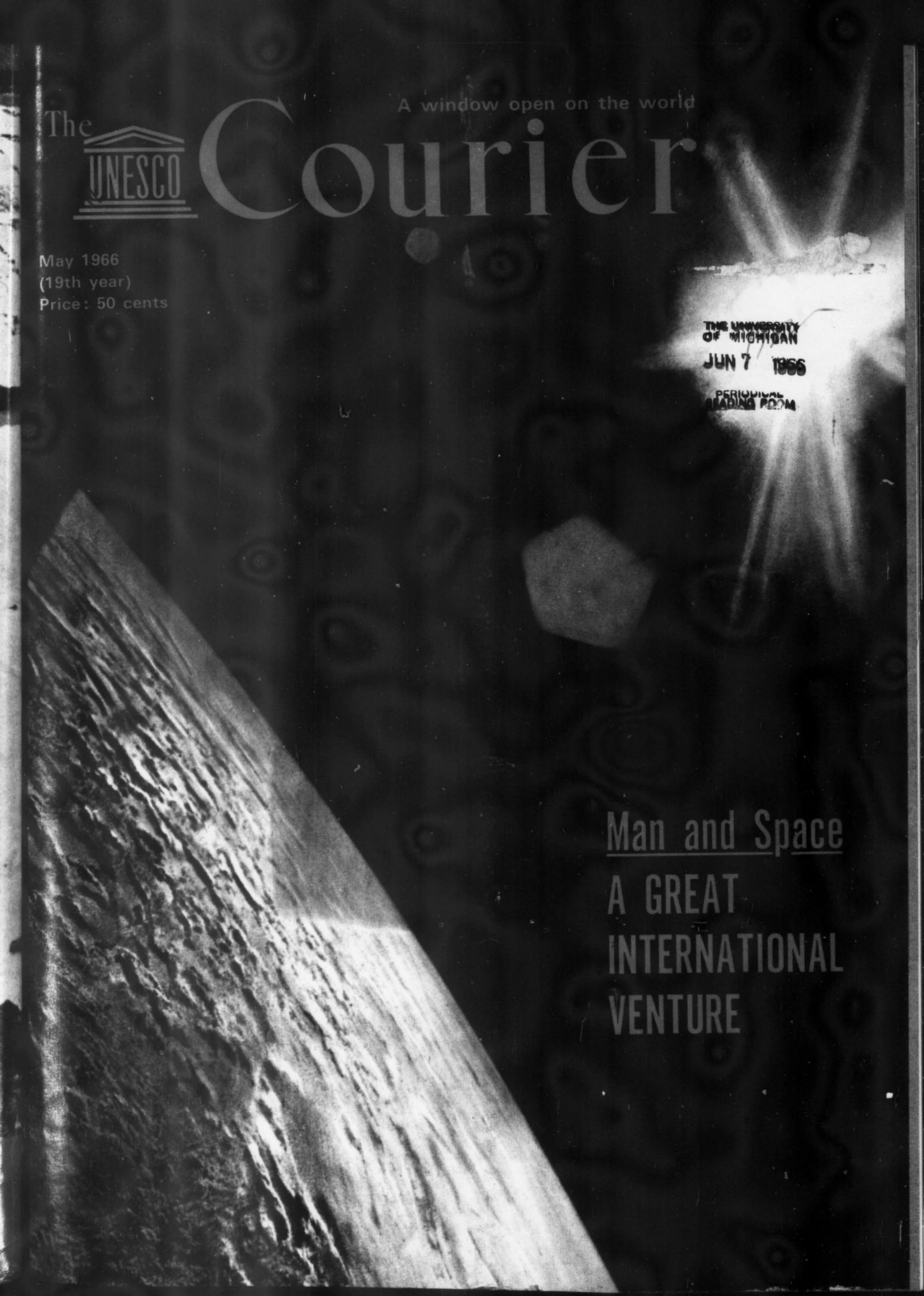

Man and Space
A GREAT INTERNATIONAL VENTURE

© Jean Suquet

Gallic dancer

Though remarkably modern in appearance, this six-inch bronze statuette of a woman dancer actually dates back well over 2,000 years. An outstanding example of early European art, it was unearthed in the Loire Valley area of France in 1861, with other similarly styled figures fashioned by Celtic artists of ancient Gaul. Celtic art continued to exert an influence in later centuries and some of its outstanding characteristics are incorporated in Roman and Gothic sculpture

Orleanais Historical Museum, Orleans, France.

TREASURES OF WORLD ART ❺

The UNESCO Courier

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Cover photo

Astronaut's view of space and earth photographed from Voskhod (Sunrise) I capsule during a 24-hour flight on October 12, 1964. Ghostly polygons of light are caused by rays of sunlight reflected on spacecraft window. Piloted by Vladimir Komarov, Voskhod carried the first trained scientists to venture into space —Boris Egorov, a research physician, and Konstantin Feokistov (see article page 27) who took this photograph, and whose studies in space included observations of the different layers of the atmosphere.

THE HEART OF THE MATTER

Five years ago, on April 12, 1961, Yuri Gagarin whirled into orbit around the earth and became the first man in space. We open this issue devoted to international co-operation in space research and exploration with statements addressed to the Unesco Courier by two famous astronauts: Yuri Gagarin and Walter Schirra. In 1962, Walter Schirra accomplished a solo spaceflight and in 1965 he was one of four astronauts who made the first manned rendezvous in space.

Yuri Gagarin:

On the occasion of the 5th anniversary of the first manned space flight, I greet all who work in the field of space research, and especially my colleagues, the American and Soviet astronauts. The age of cosmic flight and bold research ventures in the far reaches of space has begun. I am firmly convinced that greater international co-operation is needed for the mastery and utilization of outer space so that each manned flight and each launching of a space station or laboratory for cosmic research can serve man in positive and peaceful ways.

© APN

Walter M. Schirra:

It is perhaps an obvious fact, but nonetheless an important one, that there are no boundaries a hundred miles up, and there are none visible on earth when it is viewed from a space capsule.

That the exploration of space goes beyond political boundaries was no doubt in the minds of the framers of the Space Act of 1958. The act which established the National Aeronautics and Space Administration and dedicated our nation to the exploration of space included as one of its objectives co-operation with other nations and groups of nations in the peaceful applications of our space efforts.

NASA

Man and Space

A GREAT INTERNATIONAL VENTURE

by A. H. Abdel-Ghani

THE myriad of organizations, governmental and nongovernmental, national and international, scientific and technical, pursuing their legitimate interests in the field of outer space exploration seems at times to be sufficient to fill the vast expanse of outer space itself.

Each organization may be concerned with but a single facet of space exploration. The World Meteorological Organization follows with increasing interest the development of earth-orbiting weather satellites; the International Telecommunication Union must continually grapple with the growing problem of space communications; the possibility of a navigational satellite system catches the attention of the International Maritime Consultative Organization and the International Civil Aviation Organization; Unesco explores the potentialities of space communications for public information and education; and the Committee on Space Research (COSPAR) of the International Council of Scientific Unions is primarily concerned with the scientific aspects of space research.

These are but a few, and one need only consult a calendar of meetings devoted to aspects of space exploration to note the profusion of organizations involved and the variety of interests displayed.

One group, however, occupies a special position in the extensive network of organizations active in this field. The United Nations Committee on the Peaceful Uses of Outer Space is the only intergovernmental body exclusively concerned with all matters connected with outer space activities. The committee, made up of twenty-eight member states (1), has a broad membership which includes the two major space powers and a representative group of countries at varied levels of economic and scientific development, and therefore provides an effective forum for consideration of the problems of outer space. At the same time, the committee furnishes the "focal point for co-operation in the peaceful exploration of outer space" envisaged by the U.N. General Assembly.

Because of its central position, the committee is well placed to make an overall survey of international co-operation efforts in the space field; to provide a basis for objective, technical assessments of international programmes and their economic and social potentials; and to provide a "rallying point" for the many organizations engaged in this field by furnishing encouragement and support on an international governmental level.

In undertaking these important functions, the committee is assisted by its two specialized sub-committees—one scientific and technical, the other legal—and by a small group of experts in the United Nations Secretariat—the Outer Space Affairs Group. It also benefits from the experience of the specialized agencies and other bodies invited to participate in its work.

When the committee was first established, there were only two nations capable of launching earth orbiting satellites and planetary probes, the United States and the Soviet Union. At this point, there was no doubt in any mind that the primary objective for the committee in this field was to attempt to avoid the extension of national rivalries into outer space and to ensure its uses for peaceful purposes only. All plans had to reflect this overwhelming desire and necessitated, therefore, taking into account the political ramifications of any United Nations action in this area.

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(1) Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chad, Czechoslovakia, France, Hungary, India, Iran, Italy, Japan, Lebanon, Mexico, Mongolia, Morocco, Poland, Rumania, Sierra Leone, Sweden, U.S.S.R., United Arab Republic, United Kingdom, United States.

In this spirit, the committee submitted to the General Assembly in November 1963 a declaration of legal principles governing the activities of states in the exploration and use of outer space. The declaration was unanimously adopted by the General Assembly. (See article page 17).

In addition to pursuing its consideration of the legal problems and principles, the committee has presented a series of recommendations on the exchange of information, the encouragement of international programmes, the creation of international sounding rocket launching facilities, potentially harmful effects of space experiments, and education and training which lay the groundwork for further practical action to develop international co-operation.

Recently, the working group of the whole recommended to the committee the holding of an international conference in the latter half of 1967 on the peaceful uses of outer space. The conference would have two objectives: an examination of the practical benefits to be derived from space research and exploration on the basis of technical and scientific achievements and the extent to which non-space powers, especially the developing countries, may enjoy these benefits, particularly in terms of education and development; and an examination of the opportunities available to non-space powers for international co-operation in space activities, taking into account the extent to which the United Nations may play a role.

As the first decade of outer space exploration nears its completion, it is clear that many nations of the world are now aware of their stake in this new activity of mankind. The nations are determined to build the necessary international structure which will ensure the peaceful exploration of outer space for the benefit of all.

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6 ABDEL HAMID ABDEL-GHANI *is head of the United Nations Outer Space Affairs Group and secretary of the U.N. Committee on the Peaceful Uses of Outer Space. Between 1949 and 1961, he represented the United Arab Republic on several bodies in the United Nations.*

FIRST OF THE MANY. Not long ago the "space pilot" was thought of as a character from science fiction. Today, well over a score or men and one woman—Valentina Tereshkova—have flown in space, and many more are being trained to follow them. Below, animal pathfinders who paved the way for man include dogs, mice and guinea pigs.

Photos © APN

'It does not matter who reaches the moon first; what counts is the benefit to man'

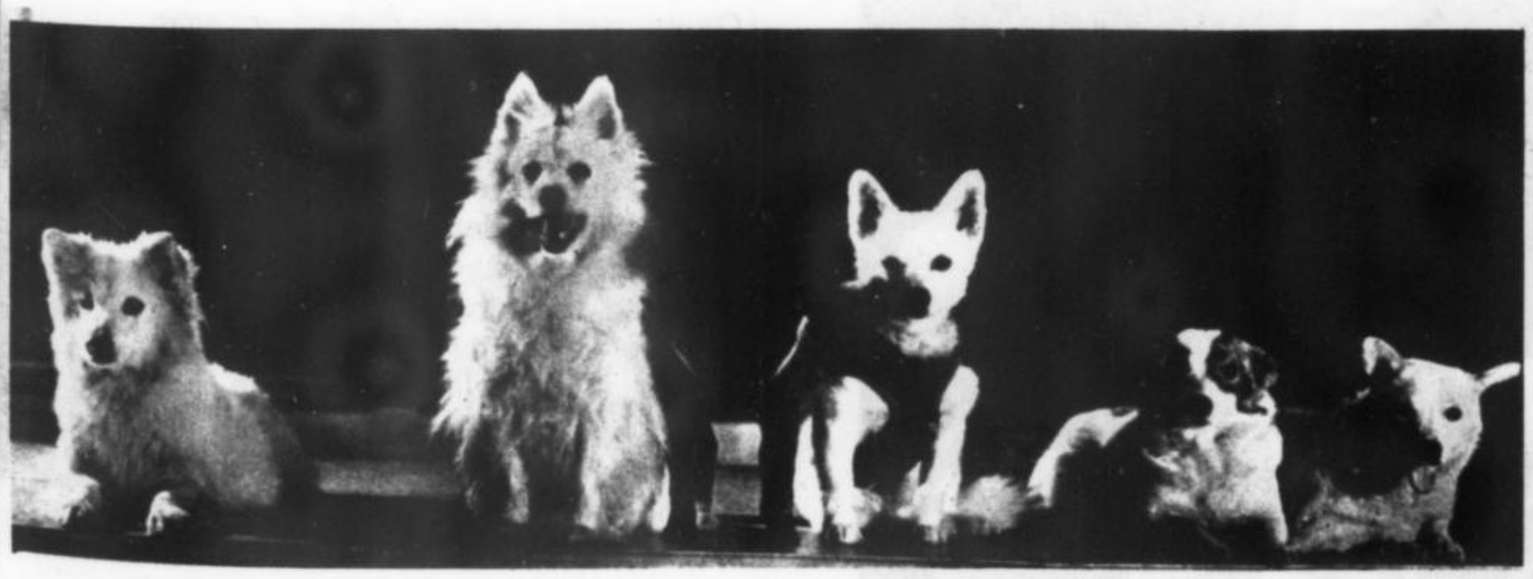
by Anatoly Blagonravov

WE are now in the ninth year of the Space Age, the period of history that opened with the launching of Sputnik 1 in 1957.

Nobody now doubts that the conquest of space is one of the paramount problems facing mankind today. The leap into space marked an important stage in the history of civilization. The most alluring prospects, hitherto undreamed of possibilities, have opened up before man.

Space research is a branch of science in which all mankind has a stake. In the final analysis, the results of the research should benefit all people the world over, irrespective of which country obtains them. The study of outer space helps man understand the general laws governing the universe that surrounds us, the knowledge gained promotes progress in science and technology, and today scientific and technical achievement reaches most of the world's inhabitants.

Man today needs space research, but the tasks involved, especially flights to outer space, demand a tremendous concentration of effort and



ANATOLY BLAGONRAVOV, *a distinguished Soviet astrophysicist, is chairman of the Commission for the Exploration and Use of Cosmic Space, U.S.S.R. Academy of Sciences.*

CONT'D ON NEXT PAGE

A gigantic natural laboratory

funds which puts it beyond the resources of many countries. It is no wonder, therefore, that the Soviet Union and the United States of America, countries in which science and technology have reached the highest development, should take upon themselves the main burden of space exploration. Their successes in this field go far beyond the bounds of mere national achievemen—they are of service to all mankind.

Scientific achievements are significant not merely because they solve various practical problems but mainly because they accelerate progress.

It took man many millenia to find out what our earth is made of and what position it occupies in the universe; to learn the rudiments of mechanics, physics, mathematics and astronomy man toiled for hundreds of years. It was this gigantic labour that prepared the way for the amazing leap forward that science has made in the past few decades, the leap that led to the accomplishment of space flights.

In a relatively short time earth satellites, spaceships and interplanetary stations have provided scientific material of tremendous value that would have required long years of persistent and often useless labour to acquire by the old methods. Space research has compelled scientists to reconsider the physics of the upper layers of the atmosphere. It has enabled man to photograph the side of the moon never seen from the earth and has provided valuable information on Mars and Venus and on primary cosmic rays, solar radiation, meteoric matter and the interplanetary medium. Space research has also thrown fresh light on the effect of solar activity on geophysical processes.

Rockets and artificial earth satellites have given us ultra-violet ray and X-ray astronomy, new methods of studying the universe. The Soviet automatic station Luna 9, making a soft landing on the moon, has sent back photographs of the lunar landscape and other valuable information. More recently, Luna 10 became a satellite of our natural satellite.

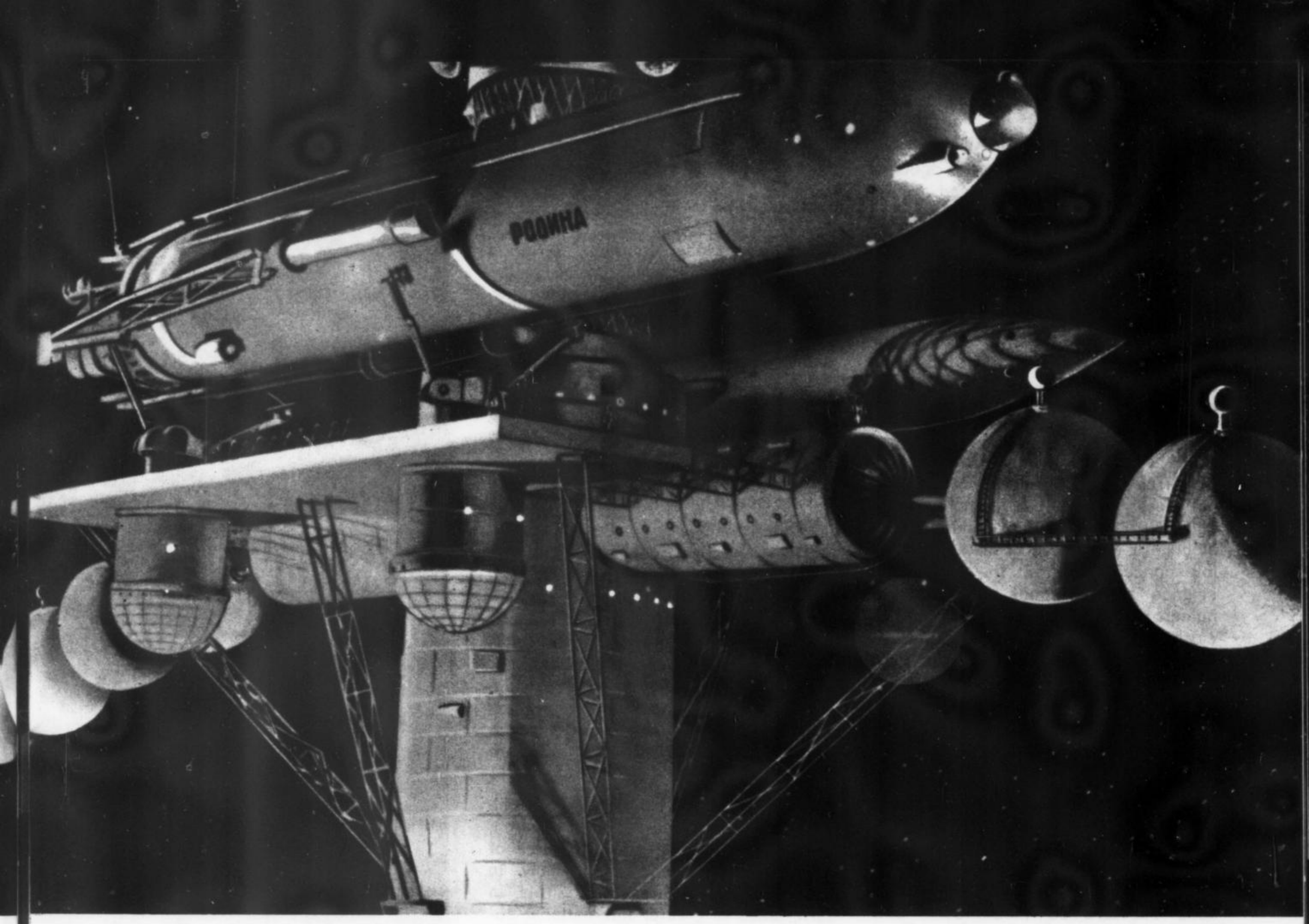
Earlier in the century scientists had already begun to feel the need to extend the study of outer space and to obtain scientific material that could be made accessible only by using the universe itself as a natural laboratory.

At first glance our planet appears to be a completely isolated celestial body, but actually thousands of threads connect the earth with the various processes taking place in outer space. It has long been known, for instance, that solar light and heat play a unique role in the life of the planet and of man; in more recent times it has been discovered that the sun is the source of other types of radiation that also exercise considerable influence on the earth. We now possess information concerning sun-earth relations whose existence we formerly never even dreamed of.

Other and more distant cosmic bodies also have an undoubted effect on terrestrial processes. Some of these bodies, for instance, are sources of what is known as cosmic radiation whose intensity determines the radiation background at the earth's surface. One could list other examples of the way the "terrestrial" depends on the "cosmic", but it will be better to sum them up by saying that a profound understanding of many earthly phenomena, the study of their real causes and the explanation of their nature,

United Technology Center

Space stations will be of vital importance in the future exploration of the universe. Whatever form they are given, they are likely to be built from prefabricated parts launched into orbit for astronaut technicians to assemble. Artist's impression (right) shows a space platform shaped like a lighthouse with a spacecraft "docked" in foreground. Drawing below shows astronauts assembling a space station with the aid of "tractor" rockets (foreground and in rear). Some scientists believe that a large wheel will be the most likely shape for a large space platform. When completed it would be spun to provide artificial gravity for the crew.



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would be impossible without proper consideration of cosmic factors.

That, however, is only one aspect. Science, as we know, progresses from study of individual phenomena to the discovery of general laws that operate in nature. This is the only way modern science can solve the gigantic problems involved in harnessing ever new and more powerful natural processes for the benefit of man.

If the researcher hopes to understand these processes fully he cannot remain on earth; his sphere of activity must widen to embrace outer space as well as our own planet.

To study the laws of the structure and evolution of the earth we must have data for comparison from other bodies in the solar system with which the earth is connected, not only by their external similarity, but also by their common origin. To study the sun we must have information about similar stars in other parts of the universe. Even the study of the shape of the earth requires observations made from space by means of artificial earth satellites.

Thus many problems of a terrestrial nature require a transition from planetary to cosmic research.

The cosmos, outer space itself, is a gigantic, inexhaustible, infinitely varied laboratory created by nature. Here we can observe and study new phenomena, reveal new laws of nature and then use the knowledge obtained for the benefit of man, for the solution of practical problems on earth.

Progress in science requires a constantly increasing volume of information about phenomena in the universe. Conventional terrestrial research must be developed but at the same time the area from which information is gathered must extend into space.

ALL scientific and technical progress depends on the speed at which many modern, disciplines develop—especially physics chemistry, astronomy, biology and cybernetics; the development of these sciences also determines the rate of production growth in the community, and these are the branches that stand in ever greater need of information from outer space.

However, the main purpose of today's space research of space flights in particular, is to learn more about the part of the universe surrounding our planet. We should not expect, therefore, the data obtained by space research to have an immediate application, although in time this knowledge will find an increasing number of uses.

Even today we can name quite a few scientific discoveries that have come to us straight from the depths of space. Take atomic energy, for example. From early days astronomers studying the sun and other stars realized that they are powerful heat radiators. It was obvious that a new type of energy was involved, since none of the hitherto known sources of energy could provide such a colossal output as that observed. The discovery of this fact was a powerful incentive to scientists to step up the study of the sun and other stars. The parallel study of the structure of matter developed intensively until man's efforts enabled him to release and harness the energy contained in the atomic nucleus.

How many still unknown sources of energy are there? How many natural processes that can be placed at the service of man does space still hide from us?

No matter how we look at the specific nature of modern science we are led to the conclusion that development of space research is absolutely essential.

As we have said, not all space problems can be solved by terrestrial observation. More and more problems are coming to the fore that must be studied outside the earth's atmosphere, either in outer space or from the sur-

CONT'D ON NEXT PAGE

Efforts repaid a hundredfold

face of other celestial bodies. For this scientists must have space vehicles capable of delivering measuring instruments and apparatus—and the researcher himself—to various points in space. The era of the study and conquest of space, the main feature of which is space flights, is an essential stage in man's development.

The space era in the development of terrestrial civilization, however, is not merely a matter of launching artificial earth satellites and making space flights. It is the use of an ever-growing concentration of the forces of science and of funds to study the numerous phenomena occurring on earth and outside the earth and to carry out extensive research on both a planetary and cosmic scale.

THE broader the scope of scientific research, the greater the scale on which it develops, and the greater the need for closer international co-operation. Research is most likely to bring the desired results if it follows an agreed programme and uses standardized instruments, and also if the data acquired are processed and analysed jointly. The effort thus expended will pay for itself a hundredfold, as joint international research conducted in recent years has proved most convincingly. The International Geophysical Year and the Year of the Quiet Sun are excellent examples of such fruitful co-operation to say nothing of the pre-arranged programmes under which the scientists of different countries study solar eclipses and other astronomic phenomena.

Today the attack on the secrets of nature is being waged with increasingly powerful scientific forces. In a number of countries mighty accelerators and big optical and radio-telescopes are being built, and the latest achievements of physics, electronics, cybernetics and other sciences are being mobilized in the service of astronomy.

In turn space exploration exerts a strong influence on the development of other fields of science and technology. For instance, it stimulates the further development of cybernetics and electronics and compels scientists to seek ways of creating microminiature laboratory equipment.

For this mighty technical array to be used most effectively, for scientific progress to be achieved at maximum tempo, there must be a broad exchange of information between scientists of various countries, concerted effort and close contact. A good example of such collaboration is the United Nuclear Research Institution in Dubna, near Moscow, where scientists from many socialist countries work side by side.

Another example of international co-operation in space exploration is the joint Soviet-French experiments in colour TV transmissions using the French Secam system via the Soviet space communications satellite "Molniya" (see page 23).

There has also been some successful co-operation between Soviet and American astronomers; in one instance a Soviet scientist, A. D. Kuzmin, worked at the observatory of the California Technological Institute for several months. Joint research produced some interesting data on physical conditions on Venus. World science forums are being held more and more frequently.

The tendency to unite scientific effort to develop international research, is one of the outstanding features of contemporary science, especially in the field of space research. This, in turn, leads to greater international co-operation and mutual assistance between different countries and different social systems, and leads to a strengthening of world peace.

The successes of modern science in designing space vehicles of various types—power carrier rockets, spaceships and steerable automatic stations—have enabled researchers to progress from the passive study of phenomena to experiments in the upper atmosphere and in interplanetary space.

Experimentation is the most rapid and effective way of acquiring knowledge. The observer always has to wait for the right conditions; the experimenter creates the conditions he needs; he can change them at will in the course of the experiment, and then observe the results of the changes.

The first experiment in space was the launching of an artificial earth satellite. It was preceded by theoretical calculations based on celestial mechanics and it proved that our previous knowledge of the structure of the solar system and the laws governing the motion of heavenly bodies was correct.

When a manned satellite went into orbit the possibilities for observation and experimentation increased immeasurably, for man's actual presence in space is essential for precise scientific work. As we have said the main purpose of our invasion of space, for the time being at least, is to obtain a more profound understanding of our immediate surroundings.

In space itself it is possible to make a direct study of phenomena and processes still unknown to science, and this of course, means that the space explorer must inevitably face the unknown. As man penetrates further and further into space that unknown will gradually become more and more extraordinary; it will be more and more difficult to relate it to what is known and it will be necessary on each occasion to find new, original approaches to problems.

Photos © APN

PIONEERS OF ASTRONAUTICS

The names of many men figure in the story of man's progress from the concept of space flight to actual accomplishments in astronautics. One such man is Konstantin Eduardovich Tsiolkovsky (above), a Russian school teacher who was born in 1857 in Kaluga. When the first aeroplanes were being coaxed to leave the ground, Tsiolkovsky was already writing about satellites, "ether suits" (space suits), the use of plants to provide oxygen and food for space travellers and even the colonization of the planets. In the latter part of his life (he died in 1935) his genius was fully appreciated, and today a crater on the moon bears his name. His vision inspired Soviet scientists who in 1929 founded an organization for studying rocket motors. Above right, members of this group are seen with an experimental rocket they built in the early 1930s. In the group is Serge Korolyov, later to become a celebrated Soviet designer of rockets and spaceships, who died earlier this year. Another authentic pioneer was a U.S. physics professor, Robert Hutchings Goddard. In the early 1920s, Goddard not only worked out calculations on rocketry and space flight, but also experimented with fuels, built rockets and actually flew them. Right, in March 1926, Goddard prepares to launch the world's first liquid fuel rocket, the forerunner of the powerful engines that hurl spacecraft into orbit today.

USIS

With science and technology at their present level such research can be done only by man, because the human brain possesses potentialities far in excess of the most perfect of our modern electronic computers and other cybernetic apparatus. Situations may arise during a space flight that have not been foreseen, and the optimum decision that has to be made instantaneously can be made only by man.

Research during space flights became still more practicable when Soviet scientists and engineers designed the multi-seat spacecraft that made a successful flight carrying astronauts Komarov, Yegorov and Feoktistov. Spaceship crews may include such specialists as astronomers, physicists, biologists, doctors and engineers; each of them, working in his own field, can conduct continuous and varied observations. There is no doubt that in the relatively near future we shall see many scientific discoveries made on board spaceships.

Another important advance in space exploration was made during the flight of the Soviet spaceship Voskhod 2 when an astronaut, Alexei Leonov, stepped ont of his ship into space for the first time; he remained outside for ten minutes protected only by the spacesuit he was wearing. This was a scientific and technical achievement that ranked with such other accomplishments as the orbiting of the first artificial earth satellite and the flight of Yuri Gagarin, the first astronaut.

AN astronaut must have a certain freedom of movement in flight if he is to carry out all the operations necessary for an effective exploration of space, but the capsule of the spaceship hampers his movements considerably. The flight of Pavel Belyayev and Alexei Leonov showed that this obstacle can be surmounted. Using a special spacesuit which supplies him with oxygen and protects him from the hazards of space, the astronaut can leave the ship, move freely in space and carry out different tasks.

A short time later this experiment was repeated by U.S. astronauts. Since it has been shown that a man can leave his ship in space, it will be much easier to do such things as joining two spaceships, building research stations in orbit and landing expeditions on other heavenly bodies.

U.S. scientists have made an important contribution to the conquest of space. Among other things U.S. spacemen have made flights along ballistic trajectories—the first step towards the future establishment of inter-continental rocket transport; they have also developed the technique of landing on water.

Valuable information was sent back to earth by the U.S. space stations Mariner 2 and Mariner 4 from the vicinity of Venus and Mars; another U.S. contribution was made by photographs transmitted by the Ranger Space Station as it approached the moon.

U.S. scientists have carried out fascinating experiments with lasers to determine the orbital position of artificial earth satellites. This was done by reflectors on the vehicle powerful enough to send the light signals of the lasers back to earth. This method of observation showed the position of the vehicle in orbit with an accuracy of 15 metres. Various types of lasers, working in different wavebands, are an important new tool for space studies.

U.S. scientists and engineers have achieved outstanding successes in the practical use of space vehicles; one example being the systems of meteorological and communications satellites they have created.

An important new stage in the conquest of space was marked by the flight of Soviet Automatic Station Luna 9. The moon being our nearest neighbour in space, its study is of tremendous interest to science, and the soft landing constitued a substantial contribution to lunar exploration.

The comprehensive study of the nature of the moon, the structure of its surface and interior, the composition of lunar matter and the physical conditions prevailing there will greatly extend our knowledge of the structure of the planets of the solar system and of the history of their origin and development. In the final analysis this will help us study our own planet and make the best use of its colossal natural resources.

The astronomers' dream of an orbital observatory beyond the terrestrial atmosphere is already coming true.

The idea of building a space station on the moon at some future date is a fascinating one. Such a station, functioning in a vacuum and in a gravitational field one sixth of the strength of that of the earth, could be an invaluable cosmic observatory and a physico-chemical laboratory in which scientists could study various processes under unusual conditions.

Soviet scientists made an extremely important step forward in space exploration at the end of 1965 and the beginning of 1966 when automatic interplanetary probes Venera 2 and Venera 3 were sent to Venus. After a three-month flight, the Venera 3 probe reached the surface of the planet on March 1, 1966 and delivered a pennant with the emblem of the Soviet Union. This precision landing was achieved by a correction of the probe's trajectory successfully carried out on December 26, 1965.

Venus became the second celestial body, after the moon, to be reached by a man-made space vehicle.

Problems on a planetary scale are being solved in the course of space exploration, and this makes it an area in which all-round co-operation between scientists of a number of countries would be most effective. Space

CONT'D ON NEXT PAGE

Weather eyes open in space

research itself, moreover, must be conducted on a broad basis. Soviet scientists are convinced that rockets and spaceships must serve the cause of peace and the progress of humanity.

Data obtained from space satellites, to complement information from ground meteorological stations, is an important factor in reliable weather forecasting. Following a Soviet-American agreement, a round-the-clock communication channel now provides for a two-way transmission of meteorological data, meteorological charts and photographs. This channel will assume a special significance when a continuous action system of weather-service satellites is put into orbit.

Some international space studies have already been carried out, among others the Anglo-Soviet radio transmissions through the U.S. satellite Echo and through the moon and Venus. Radio signals transmitted from Britain's Jodrell Bank Observatory were reflected from the surface of one of these planets and picked up by the Soviet radio-astronomic station at Zimenki, near Gorky.

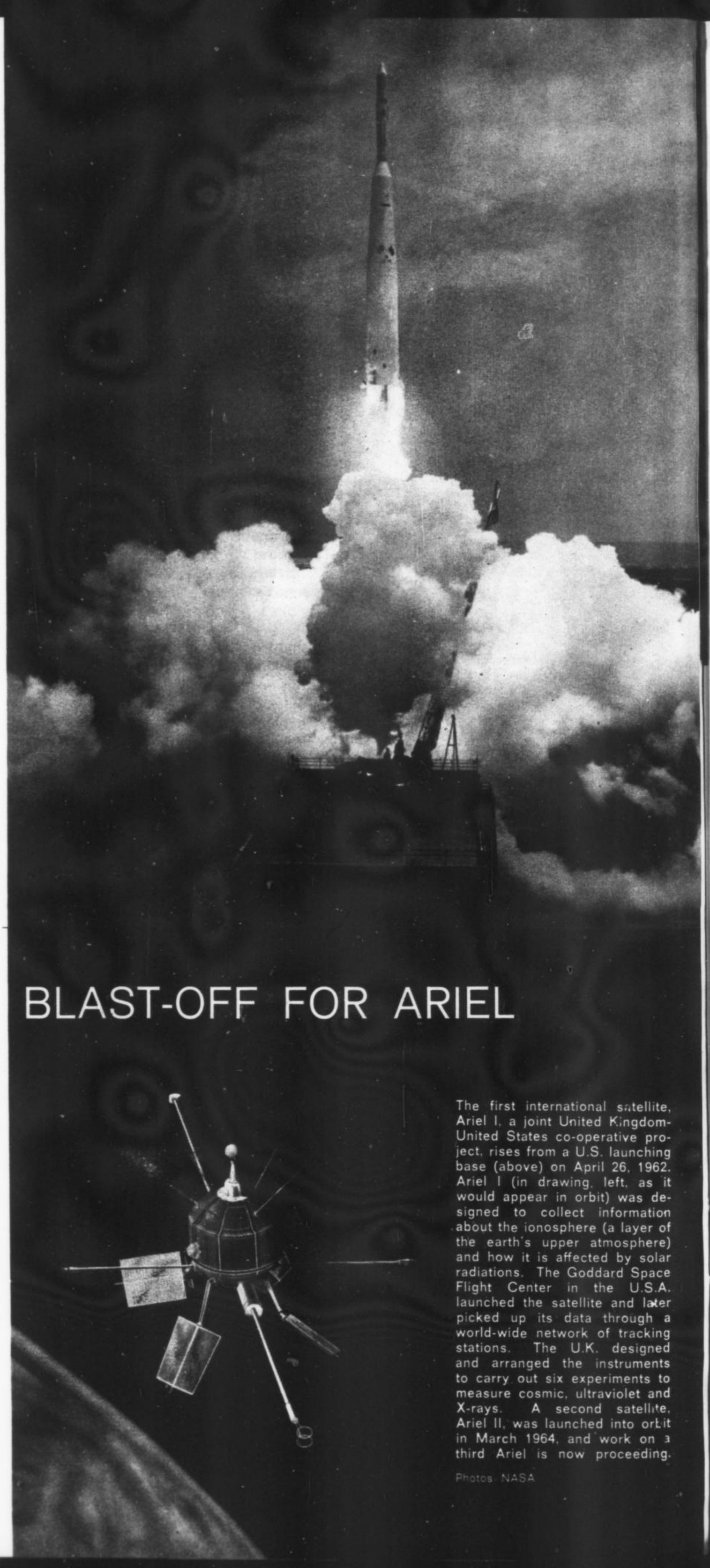
The purpose of these experiments was to extend our knowledge of the conditions under which radio waves penetrate the upper layers of the earth's atmosphere. This is of great practical importance for the development of long distance radio communication of the earth-spaceship-earth type, to ensure reliable radio communication between the earth and spaceships and other objects that in the future will be placed in orbit.

Special communications satellites, put in high orbits to ensure prolonged operation, are of major significance in establishing a world-wide system of radio communication and television. The sucessful launching of the Molniya relay satellite by the Soviet Union, for example, has made possible a regular television link between Vladivostok and Moscow.

Actually, it does not matter which country is first able to send an expedition to the moon or is responsible for some other success in space; the important thing is the benefit it will bring to people; this is the real purpose of all these achievements.

The history of science shows that when outstanding scientific discoveries are made in any country, their further development is due to the joint effort of the scientists of the whole world.

The conquest of space will be no exception.



BLAST-OFF FOR ARIEL

The first international satellite, Ariel I, a joint United Kingdom-United States co-operative project, rises from a U.S. launching base (above) on April 26, 1962. Ariel I (in drawing, left, as it would appear in orbit) was designed to collect information about the ionosphere (a layer of the earth's upper atmosphere) and how it is affected by solar radiations. The Goddard Space Flight Center in the U.S.A. launched the satellite and later picked up its data through a world-wide network of tracking stations. The U.K. designed and arranged the instruments to carry out six experiments to measure cosmic, ultraviolet and X-rays. A second satellite, Ariel II, was launched into orbit in March 1964, and work on a third Ariel is now proceeding.

Photos: NASA

'Joint enterprises are now a going concern in the exciting field of space research'

by Arnold W. Frutkin

INTERNATIONAL co-operation in the scientific exploration of space provides both a present reality which is yielding practical benefits and a highly attractive prospect for future contributions to the knowledge and welfare of all nations.

The United States civilian space agency, the National Aeronautics and Space Administration (NASA), since its establishment in 1958, has carried out a broad and varied programme of co-operative space activities involving 70 countries and jurisdictions. The objectives of this programme are to afford opportunities for the best brains abroad to participate in space research, to stimulate technical development abroad, to help reduce economic and political strain between states, and to provide a framework within which countries can pool their efforts and join in cost-sharing and complementary programmes.

Existing international co-operative space activities demonstrate the values which flow from joint participation in this relatively new and exciting branch of scientific investigation and technical development.

NASA has placed in orbit six satellites designed and engineered by scientists and engineers in Canada, France, Italy and the United Kingdom and has agreements to launch eight more co-operative satellites. From the experiments conducted with these spacecraft, the countries concerned have derived a large volume of significant information which they are sharing with the United States and the rest of the world scientific community.

Foreign scientists are invited by NASA to propose individual experiments for inclusion on NASA satellites. These proposals are reviewed in competition with those submitted by American scientists and, if selected, are funded and prepared by the sponsoring agencies abroad. Four such experiments have already flown successfully, sixteen additional ones have been scheduled for later flights and several more are under consideration. NASA has opened virtually all categories of its spacecraft, including the Apollo manned spacecraft, to foreign participation on this co-operative basis, thus providing opportunities for foreign scientists and engineers to obtain valuable data and experience.

Co-operative sounding-rocket projects have special international appeal. To nations wishing to initiate space programmes, they offer relatively low-cost opportunities on a smaller but significant scale. They offer the use of launching locations of unique scientific interest and permit simultaneous launchings in different locations, a practice required for certain scientific objectives. More than 130 rockets have been launched in joint NASA projects with 17 countries.

Sounding rocket projects have brought into being a large number of ranges in scientifically significant regions of the world—auroral, equatorial, southern hemisphere—and these ranges now make possible increasingly important programmes in rocket astronomy, meteorology, aeronomy, and ionospheric physics.

A study of atmospheric circulation of the Indian Ocean basin, with both India and Pakistan participating, has resulted in valuable contributions to scientific knowledge. A particularly interesting by-product of this bilateral programme has been the establishment of the first international sounding rocket range, at Thumba on the geomagnetic equator. This range is open to all users who follow a code of open investigation laid down by the United Nations. To the extent that unique advantages may be derived from their geographic location, there may be room for the establishment of more such ranges.

ONE of the attractive aspects of bilateral sounding rocket projects is that they tend to serve as nuclei for broadening international activity. Ionospheric studies conducted under a U.S. agreement with Norway have led to collaborative efforts among all three Scandinavian countries. Argentina and Brazil are now undertaking with NASA joint sounding rocket studies which serve as elements in an experimental inter-American meteorological sounding rocket network. This network, it is hoped, will eventually engage western hemisphere meteorologists from the Antarctic peninsula to the shores of Hudson Bay. Argentina and Brazil together have

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ARNOLD W. FRUTKIN, *Assistant Administrator for International Affairs at the National Aeronautics and Space Administration (NASA), Washington, has been responsible for NASA's programmes of co-operation with foreign governments and agencies in space science and technology since 1959 when he was appointed Director of the Office of International Programmes. He is a member of the U.S. delegation to the U.N. Committee on the Peaceful Uses of Outer Space. Before joining NASA, Mr. Frutkin served as Director of Public Affairs and later as Deputy Executive Director of the U.S. National Committee for the International Geophysical Year.*

Satellite beacons for ships and planes

formulated an agreement which provides a framework for future co-operation in space research to which these countries can bring capabilities developed in the co-operative programmes with NASA.

Co-operation in ground-based programmes has been of the greatest importance for flight projects and has permitted participation in space programmes of great scope without requiring expensive vehicle or spacecraft hardware. In meteorology, the co-operative sharing of practical space benefits has reached new levels through the inclusion of an Automatic Picture Transmission (APT) system on United States advanced meteorological satellites.

The APT camera can provide continuous read-out of cloud-cover photographs. A simple and relatively inexpensive ground station permits direct and immediate acquisition and printing of cloud-cover photographs taken by the satellite as it passes within range. Thirteen countries have acquired APT sets at their own expense and used them successfully, many reporting direct improvements in weather forecasting. Numerous other countries are acquiring the sets which offer both immediate forecasting and long-range research gains for weather service and university interests.

COMMUNICATIONS satellites made possible early dramatic transoceanic telephone and television demonstrations and have now entered the phase of direct commercial application—with the clear promise of cultural and economic benefit. The early experimental co-operation, in which a dozen countries undertook construction of ground stations at their own expense, under agreement with NASA, undoubtedly contributed to this implementation.

Another prospect, of potential benefit to both air and sea transportation, is that of navigation satellites. The increasing density of traffic on aircraft and shipping routes may make it desirable and profitable to develop a satellite navigation system which would contribute to the safety and economy of transportation, particularly on the most heavily travelled routes.

Of primary importance to programmes of space exploration and experimentation are ground stations for tracking and reception of data sent back by radio. International co-operation in the location, construction and operation of these stations is clearly essential. In all countries where NASA has established tracking and data acquisition stations, local technicians are invited to work side by side with United States personnel and, in most cases, do so. Indeed, in a number of locations, the stations are operated entirely by crews of the host country. This co-operation not only provides necessary services, but contributes to the spread of modern technologies and the continued growth of understanding.

Personnel exchanges and training arrangements are important in most international efforts. Programmes have been set up under which senior scientists from abroad may spend a year or more in research or experimental work at NASA centres. Fellowships at the graduate level are available in American universities for foreign students. Training necessary for the execution of co-operative projects in which the United States participates is made available at appropriate NASA centres. In these latter two programmes, the requirement that the sponsoring countries meet travel and subsistence costs assures careful selection of personnel selected for training, and their future utilization at home.

In each of the co-operative projects referred to, that portion which is the responsibility of the co-operating country is in fact a bona fide contribution of that country, funded by it without financial support from the U.S. Each of the projects referred to is of mutual interest to the participants and possesses valid scientific objectives. The scientific results of each of these projects are made available to the world scientific community.

What are the limitations on continued expansion of international co-operation in space research and exploration? It would be unrealistic not to recognize that constraints exist and that the primary ones are money, technology and will (which in turn may be a function of the level of appreciation of the broad benefits which can in fact be derived from an engagement in space technology).

One means of reducing costs to individual participating countries is the banding together of a group of countries, as in the European Space Research Organization (ESRO) and the European Launcher Development Organization (ELDO) (see page 24). Other,

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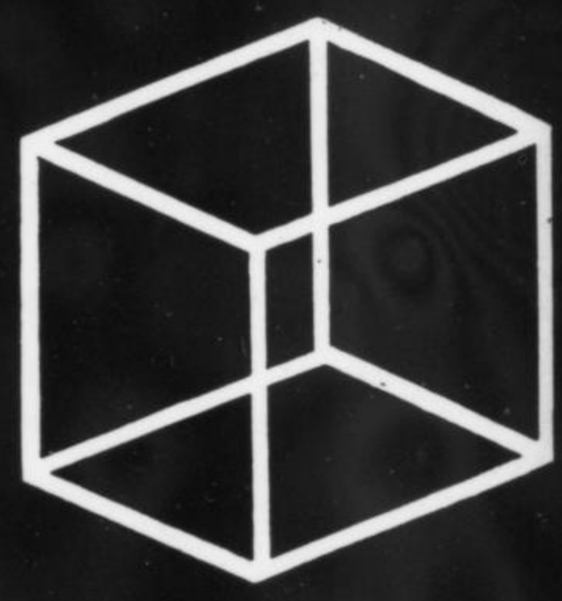
North American Aviation

TRICKS PLAYED ON HAND & EYE

Venturing into outer space, man encounters new, bewildering conditions that play tricks with his vision. The earth's atmosphere produces diffuse reflection of light, but in space the astronaut can see only bright objects illuminated by the sun and visible against an absolutely black background. Such misleading and unstable perspectives distort human perceptions of depth and shape and produce optical illusions. Astronauts are taught to beware of mirages in space.



Hold this figure (Necker's cube) at arms length and keep your eyes fixed on it. Its aspect will change. First the top (or bottom) will appear as viewed from above, and then from below. You will not be able to retain one image for very long. This illustrates the kind of optical illusion that may complicate the work of astronauts in assembling the sections of stations in space. Against the blackness of space a cube becomes diamond-shaped and a circle takes on elliptical form. Right two drawings by the Dutch engraver, Maurits-Cornelis Escher, illustrate the same kind of optical illusion. In "Belvedere", the men on the ladder are placed illogically, the lower one inside and the upper one outside the edifice; below them a seated figure contemplates Necker's cube. In "Perpetual Motion", a drawing trick makes the water falling on the wheel appear to climb again to give the mill an unending water supply.

Stresses experienced by an astronaut in flight—acceleration, weightlessness, heat, oxygen intake, magnetic disturbances—can affect his perceptions and actions. Left, checking the effect of acceleration on the human eye. Circular pattern is projected on the eye and photographed after flight to reveal change caused by rapid acceleration. erratic squiggles, Right, recalling certain works of modern art, are gestures of astronauts with electric bulbs fixed to their wrists, photographed during simulated space flight.

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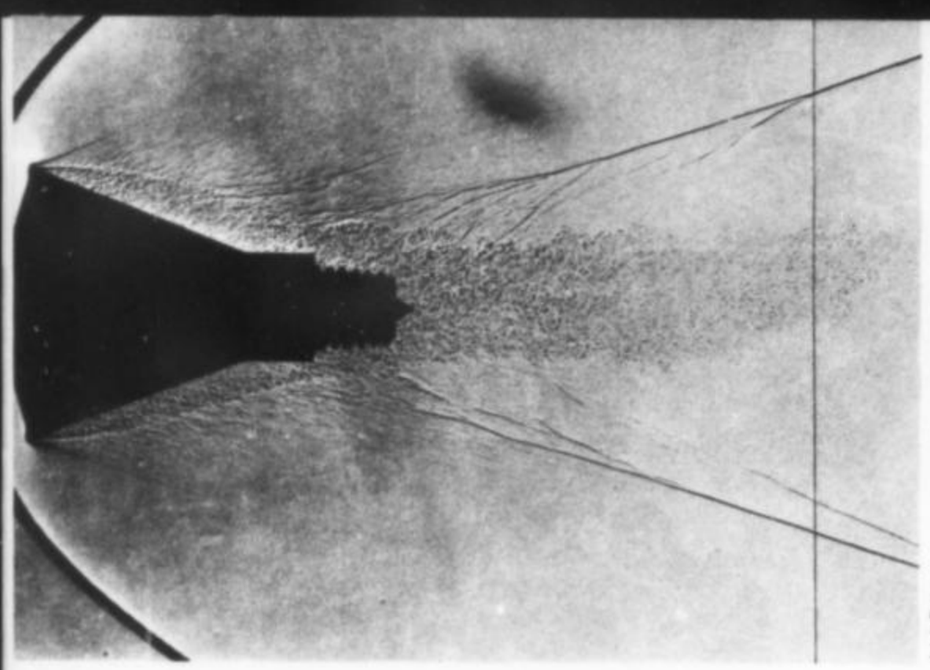
Courtesy Jardin des Arts Paris



NASA

Shadowgraph reveals the shock wave and turbulence set up by the profile of a Mercury space capsule. Tests under laboratory conditions determine how the capsule will behave at high speeds in the atmosphere.

Bridges between the continents

regional groupings might perform a similarly useful function.

The scope for advanced projects of mutual interest is also limited by disparities in the development of the required technology. The past few years of space activity, through national, regional, and NASA-co-operative projects, have, however, already established a significant base for more advanced projects. Disparities in technology can be further reduced through regional space research organizations, such as ESRO and ELDO, in which each participant concentrates on those areas of science and technology in which it is most proficient.

Finally, genuine co-operation requires the will to co-operate on the part of all participants. The will to co-operate presupposes a conviction that co-operation can serve the common interest. It is of some interest that the United States has steadfastly sought to open new opportunities for space co-operation with the Soviet Union. A certain limited success has been achieved by the two countries. Following specific proposals for co-operation by President Kennedy in 1962, negotiators were designated by both sides. The resulting talks between the late Dr. Hugh L. Dryden and Academician A. A. Blagonravov produced an agreement dated June 8, 1962.

The agreement provided for three undertakings. The first was for co-ordinated launchings of experimental meteorological satellites and the exchange of data thus obtained over a conventional communications link. This link has been established and is being used for the exchange of conventional meteorological data pending the availability of satellite data from the Soviet Union.

The second undertaking was for the launching by each country of an earth satellite equipped with absolute magnetometers and the subsequent exchange of data. The third part of the agreement was for co-operative communications experiments by means of the United States passive satellite Echo II. The communications project has been completed. The exchange of magnetic field data obtained by ground-based instruments has begun and will provide a basis for analysis of satellite data.

The most recent evidence of United States willingness to join with others in the exploration of space is President Johnson's suggestion of December 1965 that countries may wish to co-operate in a major new space endeavour of greater magnitude and more far-reaching technological implications than anything proposed heretofore. The President's proposal is, in effect, a response to the frequently-stated desire of other developed countries for greater participation in the development of advanced space technology.

Other interested nations may wish to share in the benefits which America is deriving from major advanced technological programmes through a combination of advanced management techniques, technology and a fruitful partnership of government, university and private industry. Such collaboration could contribute to the development of mutual interests transcending space technology, relating it to other technology so as to employ the total capability for broader progress and understanding for all peoples.

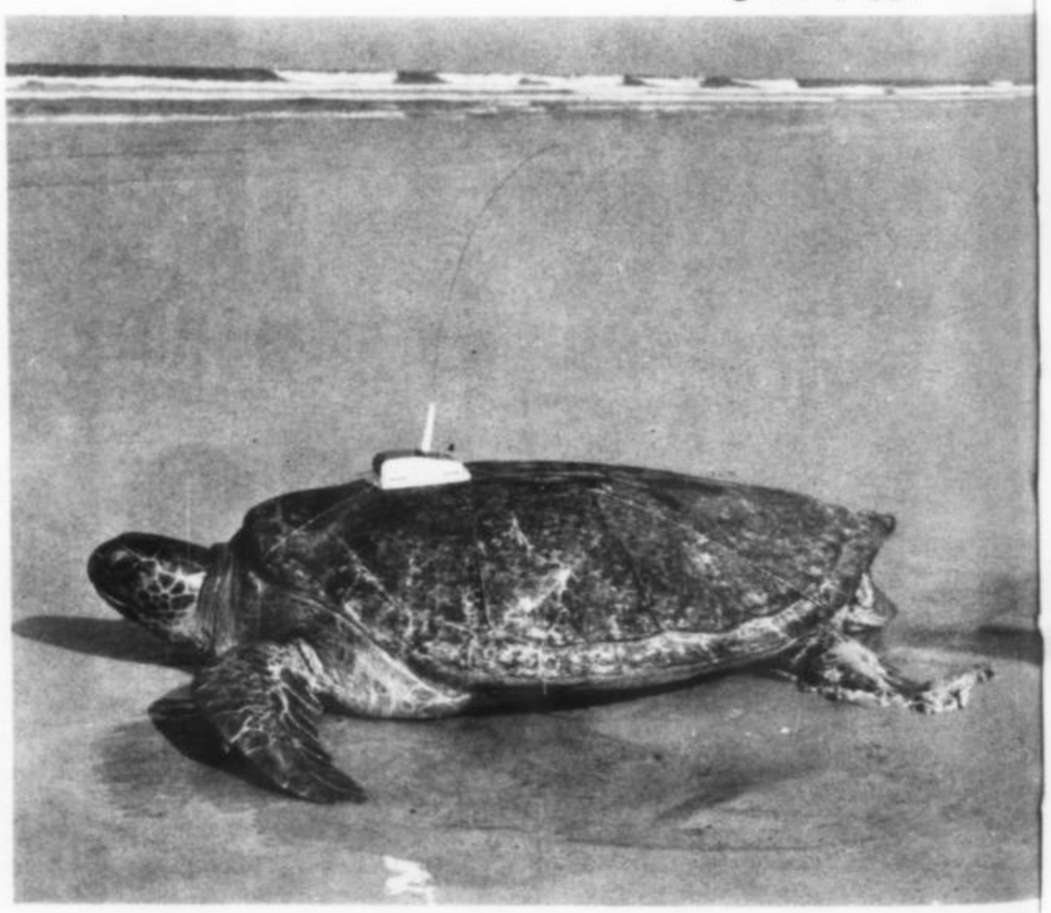
In his report to the Congress on United States Aeronautics and Space Activities for 1965, President Johnson said, "As our space programme continues, the impact of its developments on everyday life becomes daily more evident." It continues to stimulate our education, improve our material well-being, and broaden the horizons of knowledge. It is also a powerful force for peace.

"The space programme of the United States today is the largest effort ever undertaken by any nation to advance the frontiers of human knowledge. What we are discovering and building today will help solve many of the great problems which an increasingly complex and heavily-populated world will face to morrow."

TURTLE-TRACKING SATELLITES

Satellites have proved their worth in many fields, including meteorology and telecommunications. They may soon be helping zoologists discover how green turtles navigate 1,400 miles of sea to reach the sites where they lay their eggs. Professor Archie Carr, zoology professor at the University of Florida, suggests that satellites be used to track turtles equipped with a radio transmitter fixed to their shells (right). NASA is studying how to co-operate in these turtle-tracking studies.

© Archie Carr



From behind a plastic planisphere, specialist at the Bretigny aerospace centre, France, indicates (on right) point where French FR-1 satellite went into orbit, and (on left) where it passed over Europe on orbit one.

© P. Lelièvre

SPACE FLIGHT AND THE RULE OF LAW

by Eugène Pepin

- **What happens if a spaceship launched by one country lands in another?**
- **Can any nation claim sovereignty on the moon?**
- **What are the responsabilities of a country whose satellite collides with a communications satellite placed in orbit by another country?**

JURISTS did not wait for the launching of the first Sputnik, on October 4, 1957, before they started considering the problems which would arise as a result of the exploration and utilization of space by artificial satellites. The articles and discussions of the "pre-Sputnik" era, however dealt mainly with theoretical questions, such as the scope and limits of national sovereignty in space.

Very soon, Soviet and American space successes forced jurists to consider more practical problems resulting from the progress of the new science of astronautics. International and national associations of jurists studied and discussed the legal aspects of space flight, and reported their findings to various international bodies.

On December 13, 1958, the United Nations General Assembly, recognizing the common interest of mankind in the exploration and use of outer space, established an *ad hoc* Committee on the Peaceful Uses of Outer Space, and included on the list of the technical studies to be undertaken a survey of the nature of legal problems which might arise in carrying out programmes of space exploration.

The first legal principles for guidance in the exploration and use of outer space were adopted by the U.N. General Assembly on December 20, 1961, in a resolution which affirmed that:

- International law, including the Charter of the United Nations, applies to outer space and celestial bodies.
- Outer space and celestial bodies are free for exploration and use by all states in conformity with international law and are not subject to national appropriation.

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EUGENE PEPIN, *President of the International Institute of Space Law (International Astronautical Federation) is professor of air and space law at the Institut des Relations Internationales Contemporaines, Paris. He was formerly director of the Legal Department of the International Civil Aviation Organization.*

No national sovereignty in space

In this resolution, the General Assembly, envisaging the United Nations as a focal point for international co-operation in the peaceful exploration and use of outer space, called upon states launching objects into orbit to give the United Nations full information for keeping a public register of launchings.

The need for adding to the two basic principles proclaimed in this resolution became evident in March 1962, at the first meeting of the legal sub-committee of the new permanent Committee on the Peaceful Uses of Outer Space. Whilst priority was given to two important problems—assistance to astronauts and space vehicles and responsibility for damage resulting from space activities—the Soviet Delegation submitted a draft declaration of the principles which should govern the activities of states in outer space, to be signed by all countries. At subsequent sessions, further lists of general principles were submitted by the United Arab Republic, the United Kingdom and the United States of America.

THE first question to be settled was that of the general legal principles. In 1963, the U.N. Committee on the Peaceful Uses of Outer Space and its legal sub-committee discussed at length not only the principles themselves, but also the form in which to embody them: as an agreement for signature or as a General Assembly resolution. A compromise text was drafted and presented to the 1963 U.N. General Assembly, which adopted it unanimously. This was the Solemn Declaration of December 13, of the "Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space." It did not, however, satisfy all states, some of which regarded it merely as a recommendation; so the General Assembly recommended that the Committee on the Peaceful Uses of Outer Space consider the possibility of incorporating these principles in an international agreement.

This Declaration of 1963 is both a reasonable compromise calculated to unite and not divide members of the United Nations, and, at the same time a further illustration of international co-operation in space activities, complementing the resolution banning nuclear weapons in space, which was adopted by acclamation on October 17, 1963. This called on states to refrain from placing in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, or stationing such weapons in outer space in any other manner; also to refrain from encouraging or in any way participating in such activities.

The U.N. Declaration endorses the legal principles for guidance in the exploration and use of space adopted in 1961, and defines them in greater detail. The main principle proclaimed is, as before, that all nations shall be free and equal as regards the exploration and use of outer space and the celestial bodies, providing that:

- the exploration and use of outer space shall be carried on for the benefit and in the interests of all mankind;
- the activities of states in the exploration and use of outer space shall be carried on in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and promoting international co-operation and understanding;
- states shall be guided in their activities by the principle of co-operation and mutual assistance and shall conduct them with due regard for the interests of other states.

The Declaration also proclaims that outer space and celestial bodies are not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

The remaining articles contain a brief enumeration of other principles to be proclaimed in subsequent conventions.

Another problem which, since the beginning of the space age, has preoccupied countries engaged in space research is that of giving aid to astronauts and space vehicles in difficulty and assisting their return. The Declaration contains provisions on these points.

As regards space vehicles the Declaration states that ownership of objects launched into outer space, and of their component parts, is in no way affected by their passage through outer space or by their return to the earth, and it stipulates that such objects or their parts found beyond the limits of the country of registry shall be returned to that country, which shall furnish identifying data upon request before repatriation takes place.

As for astronauts, they should be regarded them as envoys of mankind in outer space and therefore given every possible assistance in the event of accident, distress, or emergency landing on the territory of a foreign state or on the high seas. Astronauts who make such a landing shall be safely and promptly returned to the state of registry of their space vehicle.

FOR the application of these principles detailed provisions will have to be laid down. A number of draft conventions have been submitted to the Committee on the Peaceful Uses of Outer Space, but no definite text has yet been drafted. Although the need for rendering assistance to astronauts in difficulties is generally accepted, discussion continues as to whether astronauts should be returned to the state of registry of their space vehicle, and whether such vehicles or their components should be returned to the country of origin in all circumstances, or only when launchings are made in conformance with the general principles of the Declaration of 1963.

The problem of the responsibility for damages resulting from activities in outer space has now ceased to be a theoretical one. Objects launched into space or fragments from them can cause damage when they fall back to the earth. For instance in November 1960 cattle were killed near the village of Olguin, Cuba, by debris from a rocket; and fragments of rockets have been found on the ground on several occasions, particularly in Canada, the United States and South Africa. With more and more objects (rocket-stages,

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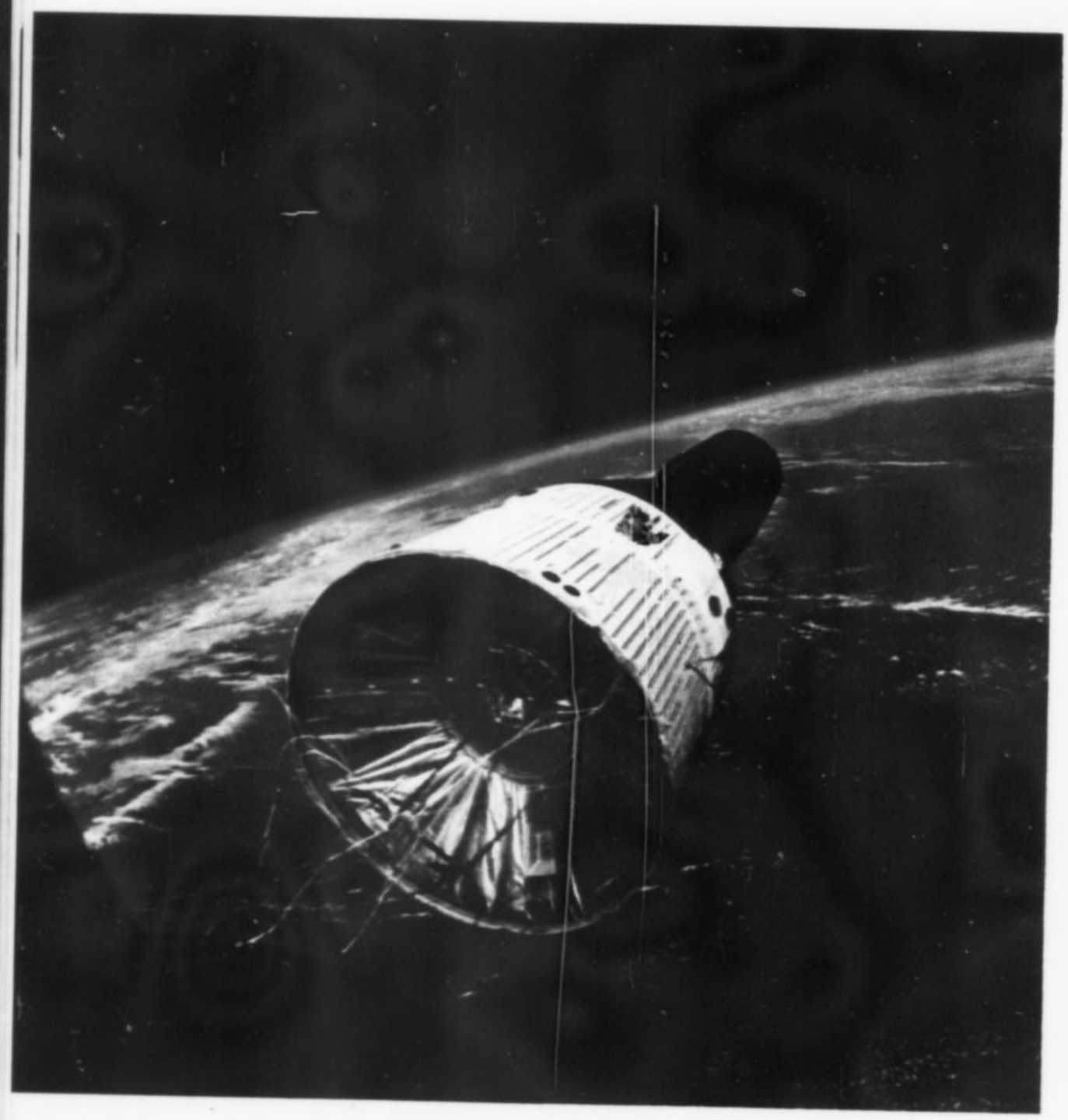
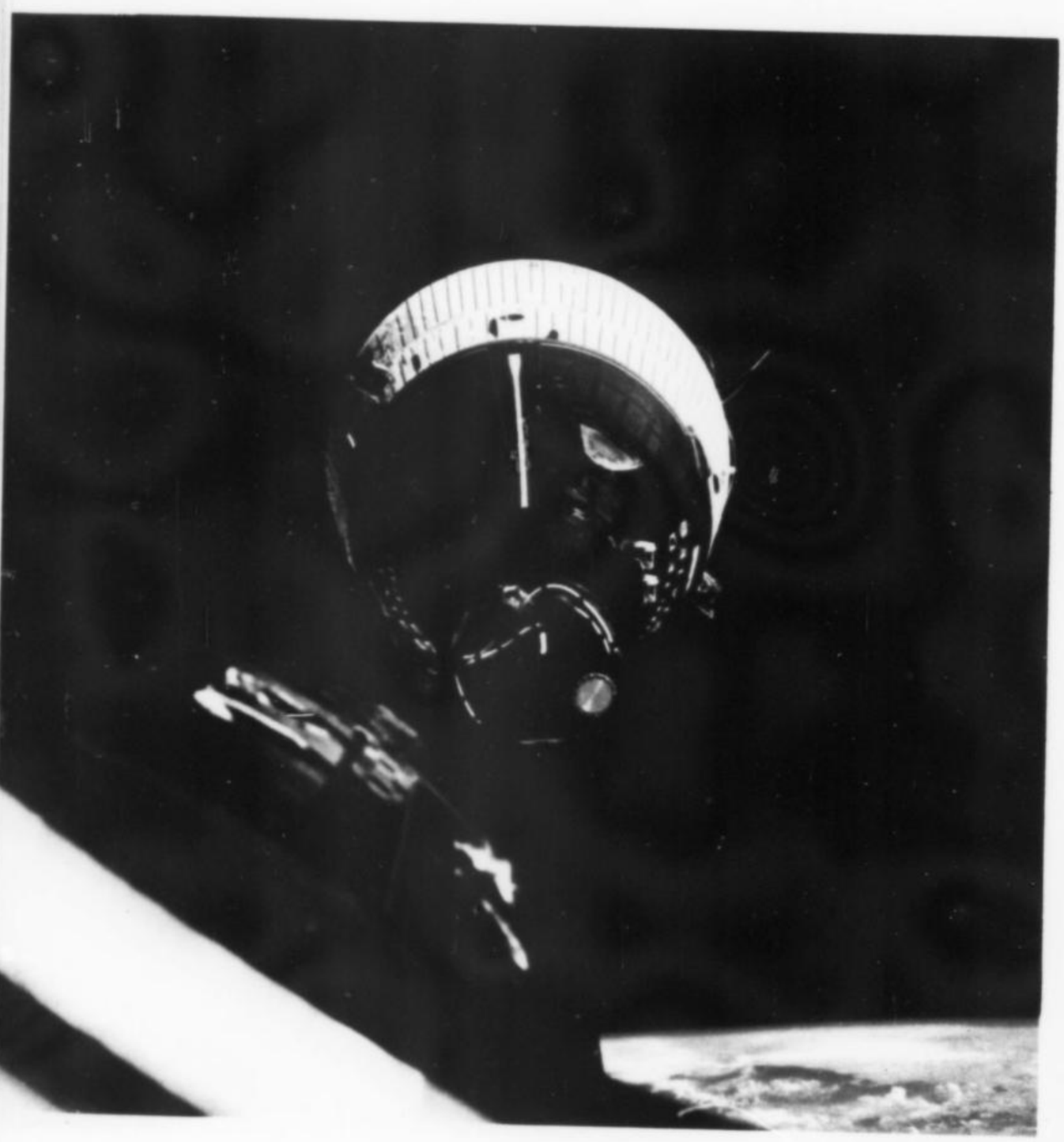
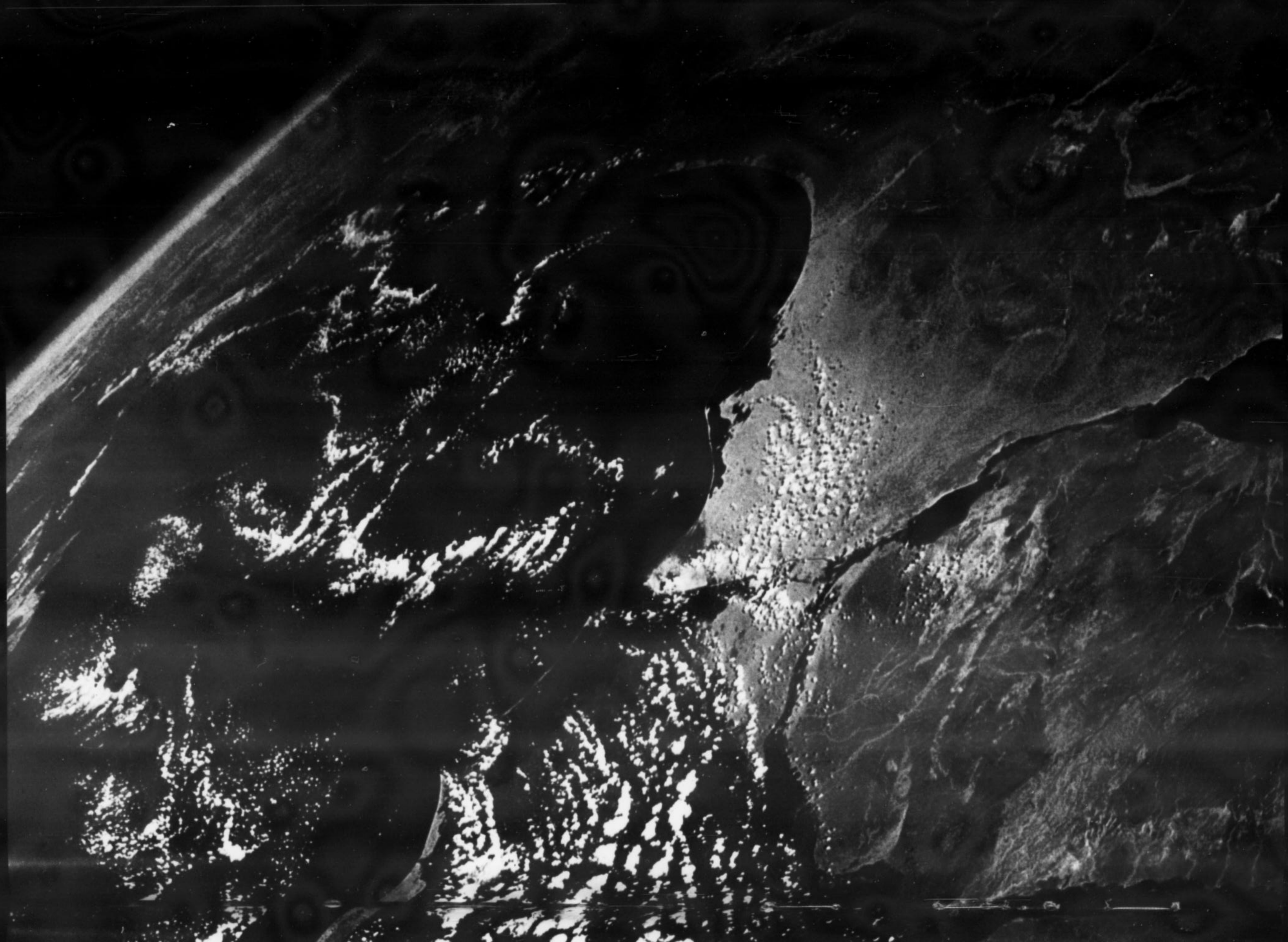
© NASA, Washington

COLOUR PAGE, OPPOSITE: *Turbulent cloud formations reveal presence of storm approaching the Moroccan coast near Agadir in this photograph taken from space by U.S. astronauts Gordon Cooper and Charles Conrad, during their eight-day Gemini 5 mission in August 1965. Today meteorologists* are no longer confined to a "worm's eye" view of the weather. The *first meteorological satellite launched in 1960 televised over 22,000 photographs of global weather conditions in eleven weeks.*







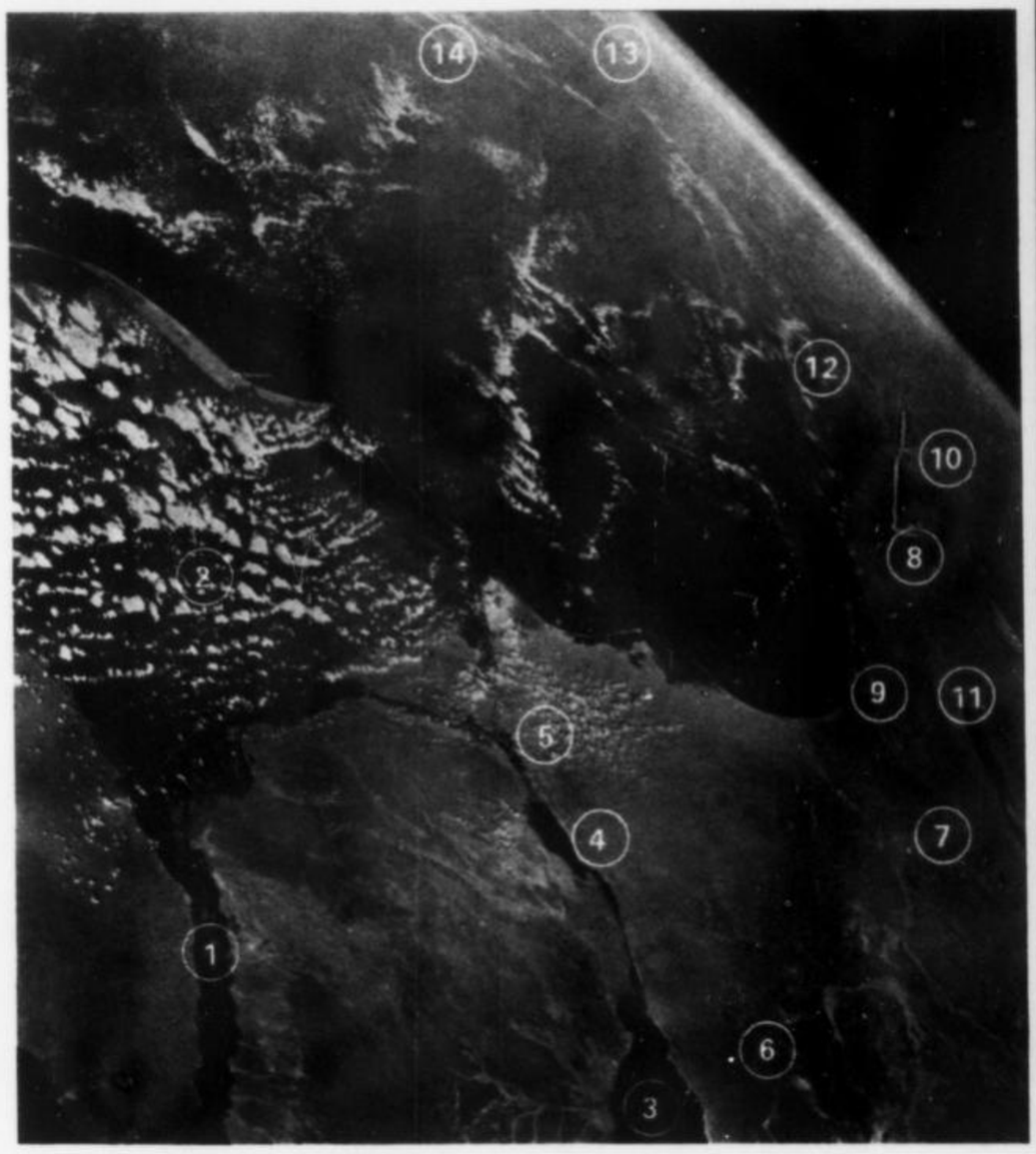
Colour page, opposite : Photographed by U.S. astronauts Frank Borman and James Lovell from the spacecraft Gemini 7, the moon hangs like a lamp against the dark backdrop of space. Gemini 7, whose nose is seen lower left, travelled 5.7 million miles and stayed in orbit for 14 days.

© NASA

ASTRONAUT-PHOTOGRAPHERS AT A RENDEZVOUS IN SPACE

Centre colour pages.

Left, two views of Gemini 7 taken as Gemini 6, with astronauts Walter Schirra and Tom Stafford aboard, closed in for the first rendezvous in space. This space chase lasted nearly six hours during which time both craft travelled three and a half times round the globe. **Top,** Gemini 7 seen from the rear. **Bottom,** the two craft nose to nose, orbiting in formation some 20 feet apart while travelling at 17,500 m.p.h., 160 miles above the earth. **Right,** a spectacular panoramic view of the eastern Mediterranean. Photographed by Gemini 7 during its 56th orbit, it reaches about 600 miles from Egypt and the Red Sea to Turkey and Cyprus. Numbered on reproduction right are (1) Nile Valley (2) Nile Delta (3) Red Sea (4) Bitter Lakes (5) Suez Canal (6) Sinai (7) Dead Sea (8) Sea of Galilee (9) Israel (10) Syria (11) Jordan (12) Lebanon (13) Turkey (14) Cyprus. Spaceborne cameras have already brought back new knowledge of great value to oceanographers, meteorologists, geologists, cartographers and other scientists. And pointing their cameras into the reaches of space, astronaut-photographers can take pictures of the moon, planets and stars without the distortions picked up from the earth's atmosphere in ground-based optical equipment.



Photos © NASA

FLOWERS VIA SATELLITE

The U.S.S.R. and France were linked for the first time by colour television on November 30, 1965, when a programme put out by Moscow was re-transmitted by the Soviet communications satellite, Molniya I (right). The programme, picked up in France by the Pleumeur-Bodou station, presented a number of films, including one on flowers from which the colour photo of columbines (left) is taken. Launched in April 1965, Molniya (Lightning), made possible the first regular television transmissions between Moscow and Vladivostok. Since 1958, increasingly complex communications satellites have been put into orbit, including Telstar I, which first relayed live TV pictures across the Atlantic in 1962. Among other vistas opened by "comsats" is the possibility of three being placed in an orbit at the right distance from the earth to relay telephone and television signals over most of the world.

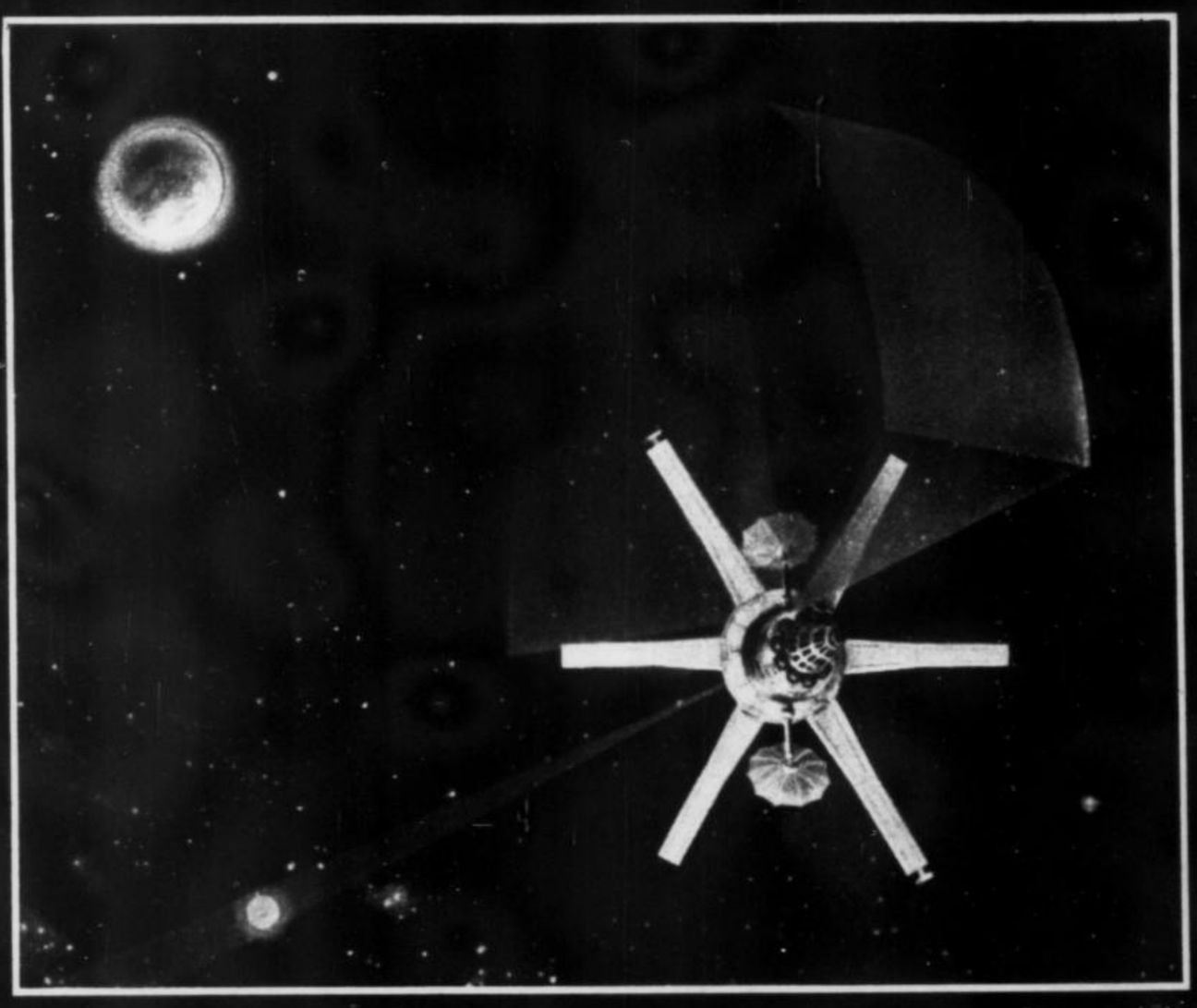


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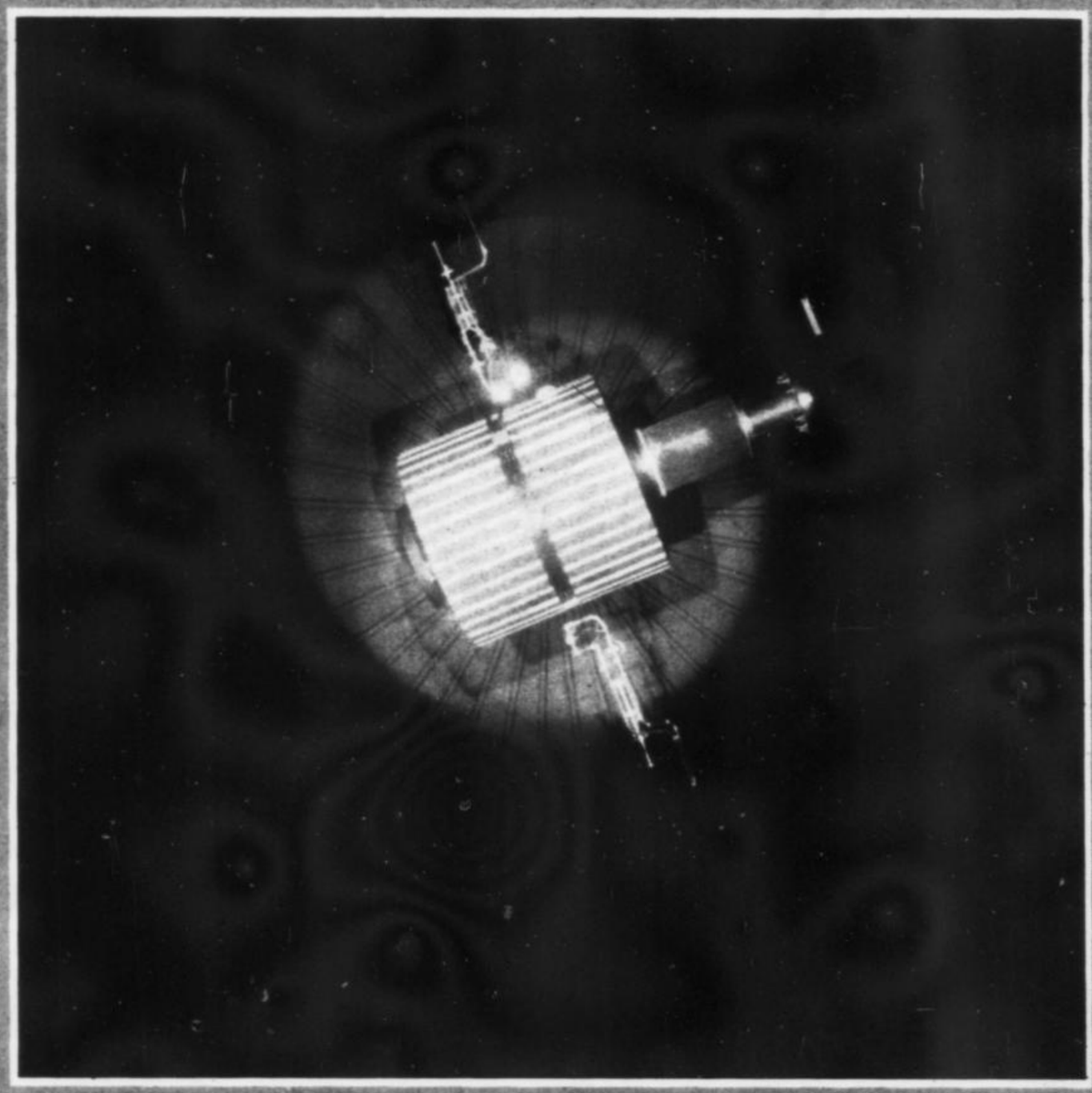
Photo APN

TEST BENCH FOR SPACE EXPLORERS

To operate successfully in the vacuum of outer space, man-made satellites have to withstand extremes of temperature—heating on the surface facing the sun and the bitter cold of space itself, with temperatures dropping as low as 270 degrees below zero C. Last January a large vacuum chamber for carrying out temperature tests on space satellites was put into service at the European Space Technology Centre, at Noordwijk, Netherlands. Right, model of the international satellite, Esro I in this chamber. Esro I, due to be launched late in 1967, will be used for studying the ionosphere and polar aurora. Far right, twin domes at the European space range now being completed inside the Arctic Circle at Kiruna, Sweden, cover telemetry equipment for picking up data transmitted by sounding rockets.



Photos ESRO

EUROPE'S GROWING STAKE IN SPACE SCIENCE

by Pierre Auger

SPACE research through international co-operation might be said to function like a three-stage rocket launching a space vehicle into orbit, with each stage completing its task and then handing over the operation for the next stage to carry it one step further.

The first stage is obviously one of paper work and planning—the co-ordination of programmes, choice of norms and general planning at the international level. An outstanding example of this stage is the work done by the Committee for Space Research (COSPAR) of the International Council of Scientific Unions.

Next comes co-operation and the joint implementation of specific parts of national programmes through special agreements and associations as, for example, the launching by U.S. rockets of Canadian, British, French and Italian satellites.

The third stage, a pooling of resources that makes it possible to carry out an international project, is today represented by various collective European programmes set up by two inter-governmental organizations: the European Space Research Organization (ESRO) and the European Launcher Development Organization (ELDO). It is primarily the work of ESRO that I propose to deal with here.

The aims of this organization are purely scientific. They are the study of conditions in outer space (including the outermost layer of the atmosphere, at altitudes of 150 kilometres, 93 miles; and beyond), and the study of celestial bodies by rockets, satellites and long distance probes launched into space.

It is hardly surprising, therefore, that the initiative which led to its creation should have come from scientists themselves. The idea was in fact originally conceived at a meeting of the space research committee of the International Council of Scientific Unions in 1960.

Subsequently, the programme and operational arrangments for the future organization were worked out in greater detail, and a preparatory commission, presided over by Sir Harrie Massey and subsidized by France, was created the same year. Between 1960 and 1964 the work of setting up the new international organization was completed, and in March 1964 a convention established ESRO.

ESRO's membership at present consists of ten European states: France, where it has its headquarters; the Netherlands, where the main technical centre is being built; the Federal Republic of Germany, where the data-processing centre is being installed;

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Sweden, in whose far north the sounding-rocket launching range is located; Italy, where the advanced research laboratory is to be built; Belgium, which is to have a satellite tracking station; the United Kingdom, Denmark, Spain and Switzerland.

The organization aims to promote collaboration among European states in space research and technology, exclusively for peaceful purposes. To do so it has drawn up a scientific and technical programme which concentrates mainly on the construction, perfecting and launching of space vehicles, sounding rockets and satellites capable of carrying scientific apparatus designed and produced by research teams in member states. These teams work, as a rule, either in universities or in large research laboratories.

In short, ESRO is designed to help scientists and researchers by providing them with means of putting their apparatus into orbit or at least of launching it temporarily out of the atmosphere. The organization will keep track of the space craft and apparatus it launches by means of a world-wide network of tracking and telemetry stations. It will pick up, process and analyse data from space.

The organization was launched with an 8-year financial plan totalling three hundred million dollars, with the reservation that annual budgets may, after the preparatory period, attain fifty million dollars. This clearly rules out any very major projects such as sending men to the moon; and in any case ESRO has decided to confine itself to unmanned space vehicles. It has, however, been able to draw up a programme of rocket and satellite launchings that will enable scientists to carry out a variety of experiments in cosmic physics and astrophysics. The organization will procure sounding rockets from France and the United Kingdom; satellite-launching apparatus from the United States.

THE programme provides for the launching of some hundreds of sounding rockets able to reach altitudes of between 150 and 300 km. (90-190 miles); and of a series of artificial satellites of three types: small satellites placed in orbit by American Scout rockets, medium satellites orbited by Thor Delta rockets, and large satellites weighing about a ton and needing far more powerful launchers. It is probable that the large satellites will be placed in orbit by the 3-stage rockets of the type now being constructed by the European Launcher Development Organization (ELDO), an organization which was set up at about the same time as ESRO through the association of seven governments, those of the United Kingdom, France, the Federal Republic of Germany, Italy, the Netherlands, Belgium and Australia.

The first item on ELDO's programme is the design, development and construction of the three-stage "Europa" satellite-launching rocket. The first stage will be the British Blue Streak rocket, the second, the French rocket Coralie and the third, a German rocket. The satellite test vehicles are being built by Italy, while Belgium and the Netherlands are producing various types of telemetry and guidance equipment and Australia is providing the launching range at Woomera.

What kinds of experiments are carried out with the aid of apparatus which has been—and is to be—placed in these rocket-heads and satellites? They are designed to make a study of the uppermost strata of the atmosphere and the ionosphere, in particular the auroral region, for which the site at Kiruna, 200 km. (125 miles) inside the polar circle, was selected; and to investigate the solar radiations which are the cause of most of the phenomena occurring in this part of the atmosphere. Data will be obtained on

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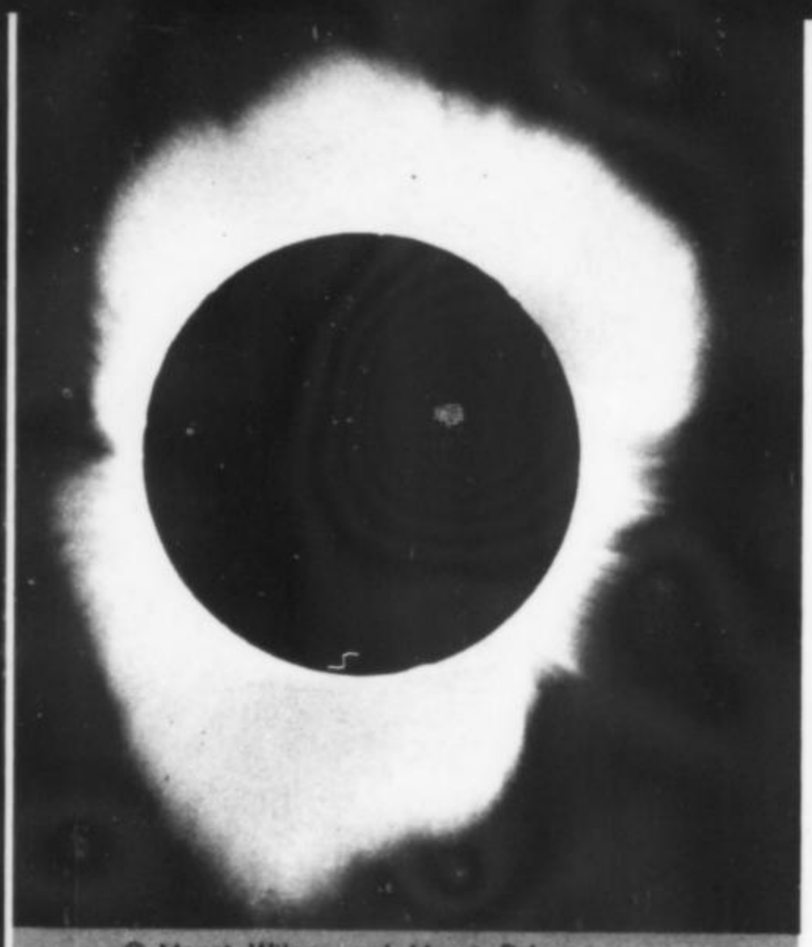
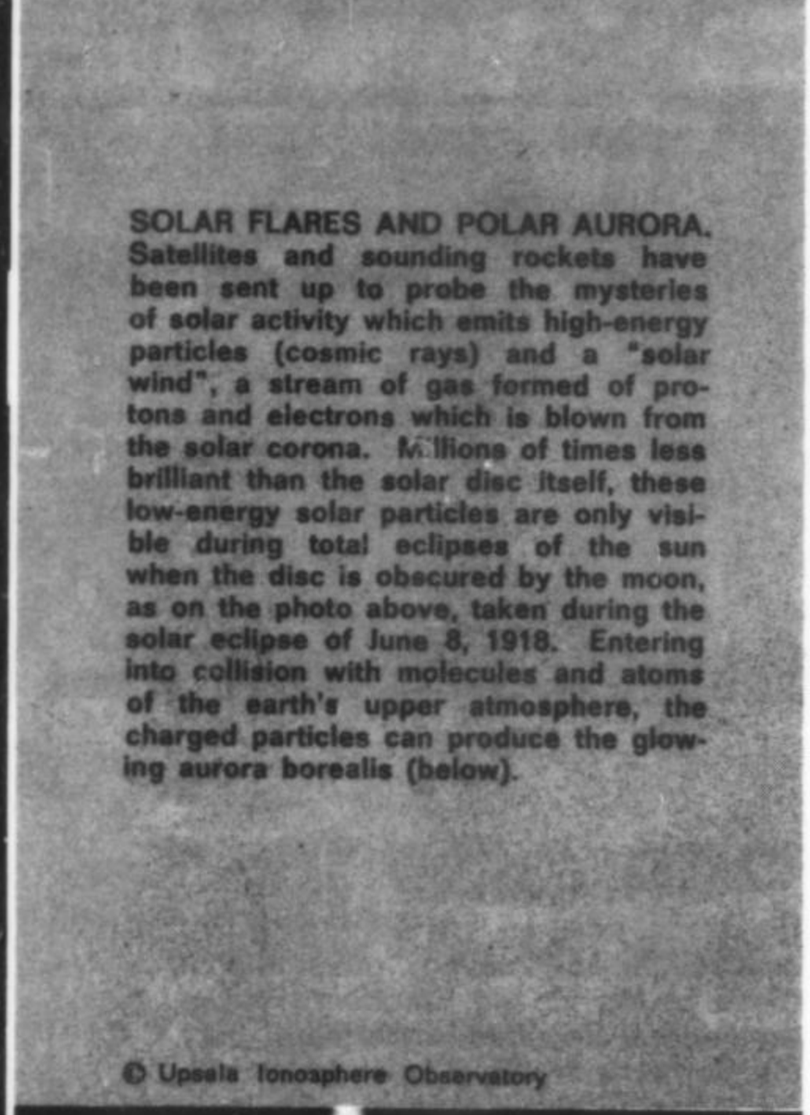


© Mount Wilson and Mount Palomar Observatories

SOLAR FLARES AND POLAR AURORA. Satellites and sounding rockets have been sent up to probe the mysteries of solar activity which emits high-energy particles (cosmic rays) and a "solar wind", a stream of gas formed of protons and electrons which is blown from the solar corona. Millions of times less brilliant than the solar disc itself, these low-energy solar particles are only visible during total eclipses of the sun when the disc is obscured by the moon, as on the photo above, taken during the solar eclipse of June 8, 1918. Entering into collision with molecules and atoms of the earth's upper atmosphere, the charged particles can produce the glowing aurora borealis (below).



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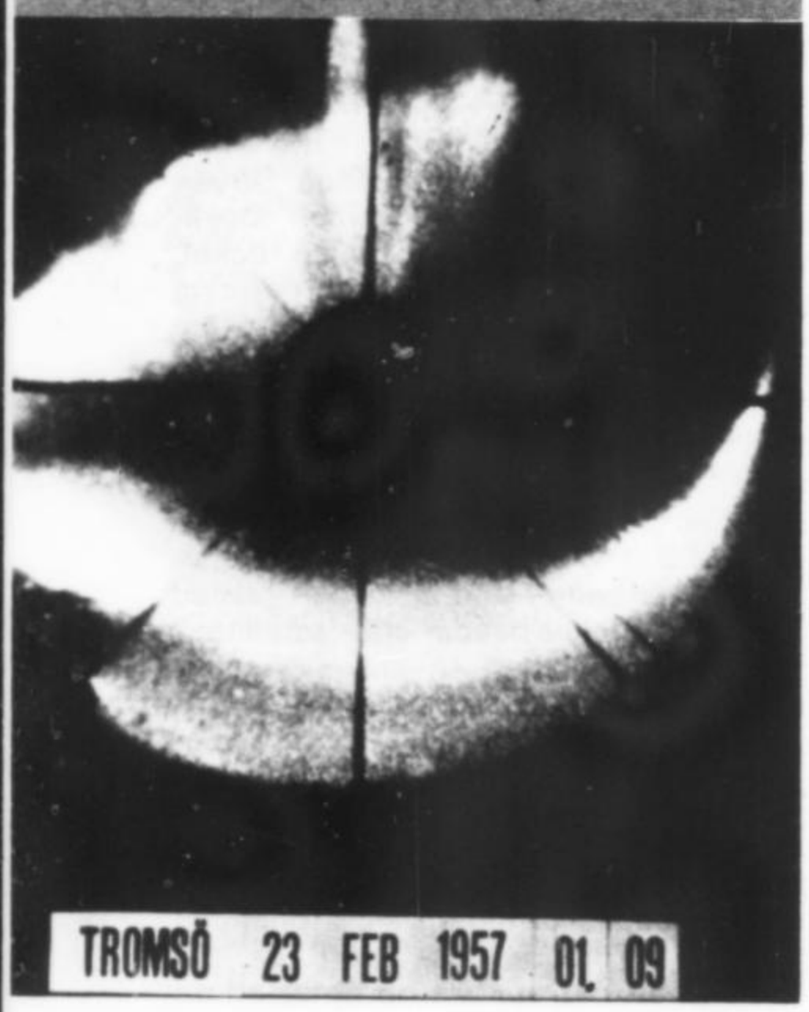

electronic density, the temperature of electrons, night glow, the turbulence and temperature of the upper atmosphere, and also on the ultra-violet, X and gamma rays of the sun in its periods of activity and calm.

Special activities will be undertaken during the annular eclipse of the sun (when the moon's disc eclipses the whole of the sun except an outer ring), which is due to occur on May 20, 1966. Five small rockets of the Arcas type are to be launched at regular intervals; also three large Centaure-type rockets immediately before, during and directly after the maximum eclipse phase.

The most important part of the scientific programme is obviously that relating to satellites. The first two satellites are to be launched in 1967 by the National Aeronautics and Space Administration (NASA), from American bases. One of them, Esro I, will be an auroral satellite; the other, a cosmic satellite. In other words, the first will study the particles responsible for the upper atmosphere auroral displays of light in the polar regions; the simultaneous launching of rockets during the useful life of the satellite is also planned.

To obtain maximum results from these simultaneous launchings a telemetry station will be set up at Tromsö, in Norway. Here the data transmitted back to earth will be processed and analysed immediately. The second satellite, Esro 2, is to concentrate on cosmic radiations, in particular those emanating from the sun. It will also study the rays "trapped" in the earth's magnetic field and circulating in the vast cloak of radiation known as the Van Allen belt.

Yet a further step forward will be marked by the launching, scheduled for 1968 and 1969, of medium stabilized satellites, that is, satellites able to train their apparatus on to any particular region of the sky—the sun, a planet, or certain stars. The first of these (named TD 1 because it will be launched by a Thor Delta unit) is to concentrate on spectrographic observation in radiation fields extending from the infra-red to gamma ray radiation which, because of atmospheric absorption, never reaches the earth's surface.

It is hoped that interesting sources will be revealed by these means; but the satellite will in addition make a more detailed survey of the ultra-violet spectra of certain stars. As is known, our ignorance of these spectra is an obstacle to checking the validity of theories about the origin and evolution of the stars. Lastly, attention will be paid to X and gamma rays: the former in relation to radiations which may have their source actually in space; the latter, in relation to stellar radiations.

The second medium satellite, with a total weight of approximately 400 kg., is to be placed on a polar orbit, so as to pass over both the earth's polar regions in succession; and its main task will be to study the sun and its effects during the phase of its maximum activity. The experiments it will carry out will be related to the ultra-violet and X-ray radiation from the sun and the low energy particles streaming from the sun, which are the sources of the solar wind.

Other experiments will concentrate on the emission of light from the upper atmosphere due to the ionizing influence of the sun; and lastly, on the electronic density in the upper part of the ionosphere, studied from outside the atmosphere instead of by soundings from the earth, as hitherto.

The fifth medium satellite Heos, on which work has now begun, will be launched into a highly eccentric orbit. Heos will concentrate on the terrestrial and solar magnetic fields, the solar wind, and the radiation fluxes occuring in the zone outside the magnetosphere, a zone which, thanks to its elongated orbit, it will be able to explore. It will attain a distance of more than 200,000 kms. (125 000 miles) from the earth.

We now come to the most ambitious part of the satellite programme—the construction and launching of a large astronomical satellite about a ton in weight, designed for detailed spectroscopy of the stars.

Some features of this satellite still remain to be defined. But its equipment will include telescopes that can be accurately directed on selected stars, spectrographic devices, and ultra-violet radiation receivers or detectors.

Work on the European Space Technology Centre (ESTEC) at Noordwijk, the Netherlands, the European Space Data Centre (ESDAC) at Darmstadt, Federal Republic of Germany, and the launching base at Kiruna, Sweden, is now in full swing. The launching base may even be inaugurated this year, and ESTEC and ESDAC in the course of next year. Four satellite tracking stations are being built, located respectively in Belgium, Alaska, Spitsberg and the Falkland Islands, so as to cover as much of the surface of the globe as possible. Lastly, a site has been selected near Rome for the European Space Research Institute (ESRIN).

It can thus be seen that the organization has made great strides since it was officially set up in April 1964. Meantime, several sounding rockets have already been launched from the Italian base in Sardinia, for European scientists are impatient to pursue their research.

Photos © APN

Floating through the air with the greatest of ease, astronaut Adrian Nicolaiev learns to cope with conditions of weightlessness during training session in an aeroplane in flight.

WHY WE ARE OUTWARD BOUND

by Konstantin Feoktistov

KONSTANTIN FEOKTISTOV, *the author of this article, learns to withstand acceleration stresses. On October 12, 1964, the Soviet spaceship Voskhod 1 made a 24-hour flight. It carried Vladimir Komarov, the pilot, Boris Egorov, a research physician and Konstantin Feoktistov who carried out scientific studies while in flight.*

WHEN the first artificial earth satellite was launched a friend and I made bets on the year in which the first manned vehicle would go into orbit. Our prophecies were both wrong, but I won—either by pure luck or because I was the more optimistic. Yuri Gagarin's flight took place much sooner than could have been foretold nine years ago.

What is it that compels man to leave the confines of his own planet? Is it rational to spend so much effort and material on the exploration of outer space when there are still so many unsolved problems in our own world? To what extent is this expenditure on sputniks and luniks and other vehicles justified when so many people still lack food, clothing and proper housing?

It is doubtful whether anyone would try to give a definitive answer to these questions. Each answer could, at best, be only one of many possible points of view.

The idea of space travel has absorbed me for many years and will, it seems, keep me busy till the end of my life. Here I should like to set down some ideas on the subject that derive from my own personal experience.

When I was about ten I came across a book called *Interplanetary Travel* and, reading it, caught the "moon disease". The flights seemed to me to be so real and so easy to accomplish, and the need for them was so indisputable that, with all the sincerity of youth, I accused the grown-ups around me of laziness and lack of scientific acumen. I could not reconcile myself to the idea that earth-moon communications had not been established. So my elder brother and I decided to get busy on the problem immediately.

We had to postpone our naive plans, however. War broke out, my brother was killed and I was wounded.

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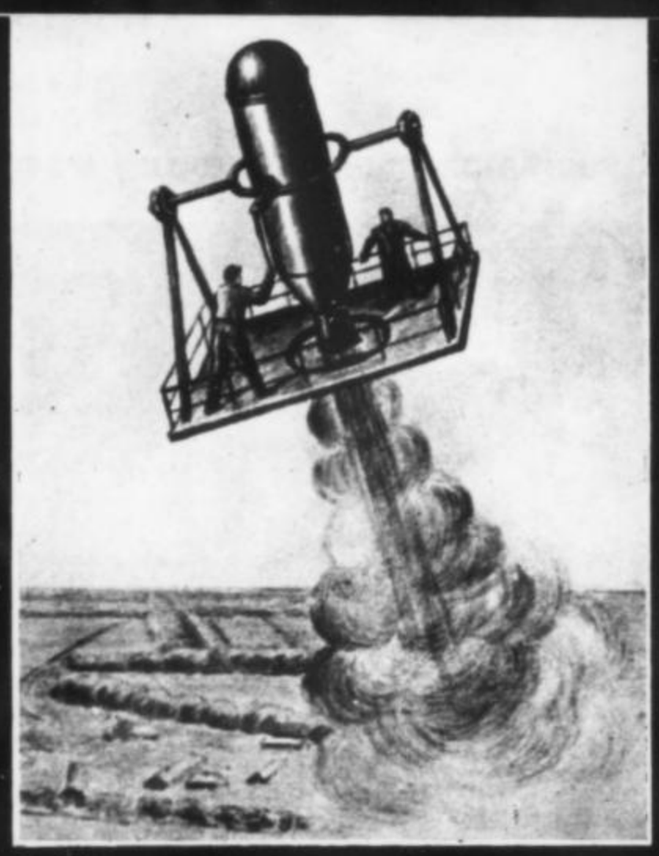
CENTURIES BACK

Cyrano de Bergerac, the French writer, in "Voyages to the Moon and the Sun" (1650) imagined a weird method of becoming space borne. His hero reasoned that the sun causes the morning dew to rise, so went aloft by attaching vials filled with dew to his body. On the moon he encountered another earthling, carried there in a machine powered by geese (above). This was the adventurous traveller described by the English author, Francis Godwin, in "The Man in the Moone" (1638).



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NOT SO LONG AGO

In his cell at the Peter and Paul Fortress in St. Petersburg, where he had been imprisoned for revolutionary activities, a young Russian, Nicolas Kibaltchitch (1853-1881), speculated about space flight and devised a rocket type machine for cosmic travel. Drawing above is based on his sketches of this rocket-propelled spacecraft.

© Hachette

YESTERDAY

The 19th-century science fiction works of Jules Verne were a mixture of scientific accuracy, astute speculation and outright imagination. In "Around the Moon," a 900-ft cannon fires a capsule into space. Illustration shows Verne's astronauts floating helplessly in a state of weightlessness in their cabin. But Jules Verne correctly foresaw many space problems, including the need for tremendous speed to escape earth's gravity and for a means to change course while in space—by the use of retro rockets.

At 40, I have not lost hope of landing on the moon

Despite all the dramatic events of the war years, my dream of space travel never left me; it was with me when I enrolled in the higher technical school and when I was working as an engineer. I chose it as the subject of the thesis I presented for the degree of candidate of science.

Two years ago I spent a day and a night in orbital flight as a member of the crew of the spaceship Voskhod I. My dream has still not been fulfilled, but I am on the right road. There is every reason to believe that the age limit for astronauts will be progressively raised as technical improvements are made, and although I recently celebrated my fortieth birthday I have still not lost hope of one day stepping out of a spaceship onto the moon. If I do not, my life will seem incomplete.

The "Call of the Cosmos" emerged from a dream. Like almost every dream it came before its time, far in advance of man's technical capabilities. Eduard Tsiolkovsky (an early Russian theorist on the principles of space flight, see page 10), translated Jules Verne's pure fantasy into a potentially attainable scientific concept.

The generation born at the beginning of this century began the job of embodying Tsiolkovsky's ideas in metal and of turning his prophecies into convincing facts. At first the work was sporadic and unorganized, and as has often been the case in the history of science, eccentrics and enthusiasts watched over the cradle of the new-born science.

When the group for the study of rocket motors (GIRD) was founded in Moscow, followed by the laboratory of gas dynamics (GDL) and still later, in 1955, by the rocket institute, experiments that had hitherto been rather primitive became part of the state plan of the U.S.S.R. One of the founders of GIRD was Sergei Korolyov, later a member of the U.S.S.R. Academy of Sciences and a designer of carrier-rockets and spaceships, who died at the beginning of this year.

If a man has begun to take an interest in a problem, he is already mature enough to penetrate more deeply into it. Every problem is a challenge to man, every problem makes him think. Thinking leads to plans for the solution of the problem. A sort of chain reaction sets in. When you have given some thought to the problem of supplying power for a heavy interplanetary vehicle you come to the conclusion that an expedition to another planet cannot use chemical fuel—the engines must be more effective, they must be ion or plasma motors.

And when you think of the duties of the crew that is to carry out a certain mission you also begin to think of the people who will compose that crew. This naturally gives rise to problems of providing food, water and air for the crew during flight. Here it is obvious that a complete ecological cycle must be maintained on board the spaceship—the crew must be provided with everything necessary to support life, and their body wastes must be eliminated or, better still, used in a rational way.

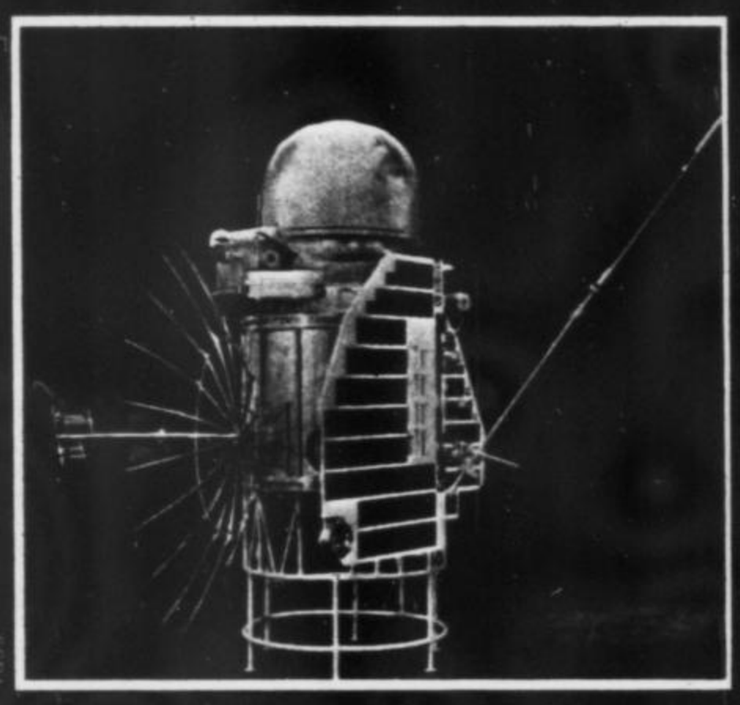
As this huge skein of problems is unravelled we begin to visualize the space expedition of the distant future. The very possibility of visualizing turns a man's thoughts, whether he wishes it or not, to the search for new solutions.

From dream to reality

From far off times man has been obsessed by the idea of space travel, and usually the goal of his imaginary journeys has been the moon. Indeed, story tellers, poets and writers reached the earth's natural satellite well in advance of the satellite moon probes sent out by space science. To do so they devised a wealth of ingenious, however impractical, methods.

TODAY

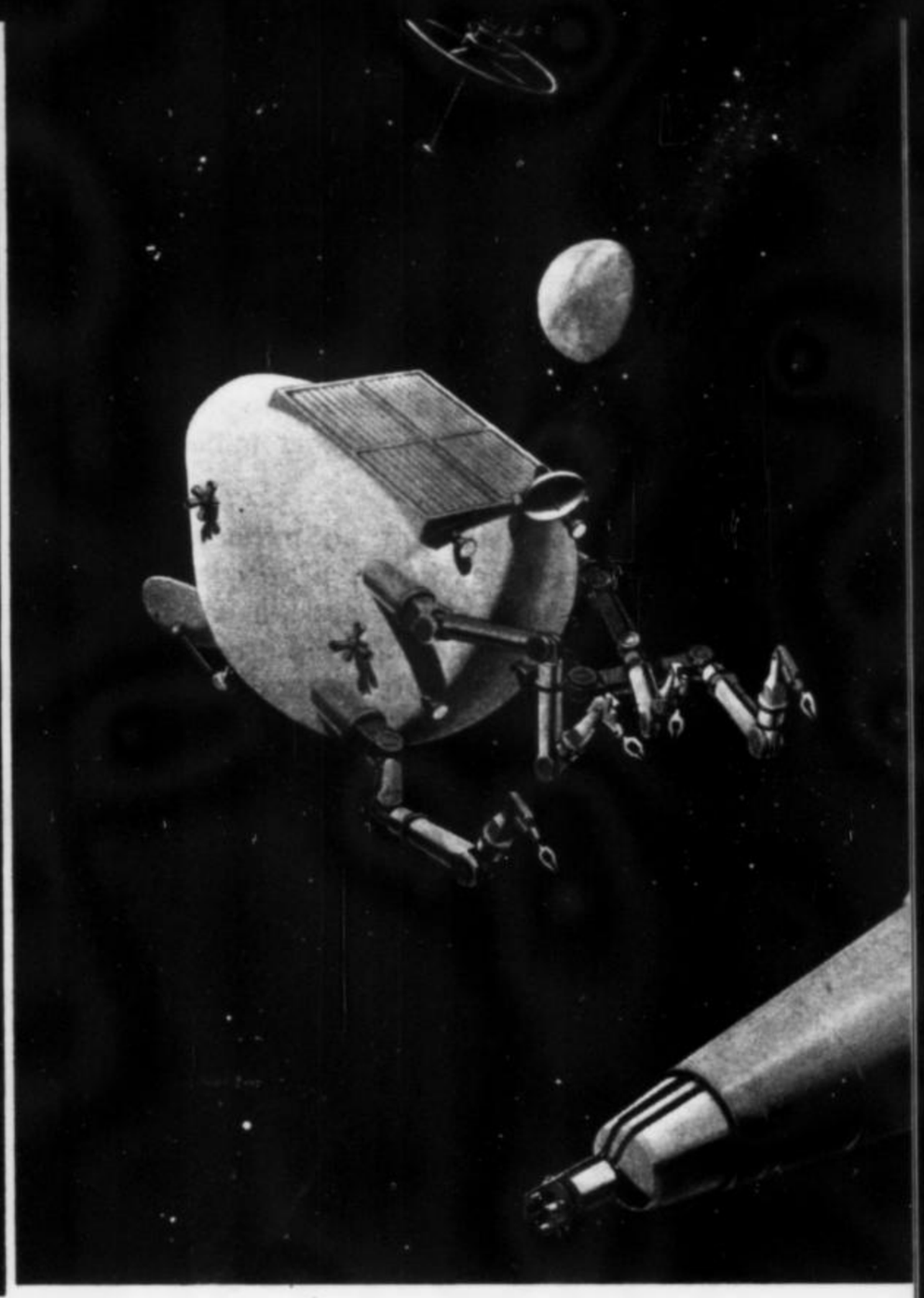
The first guided automatic interplanetary station was launched towards Venus by Soviet scientists on February 12, 1961 (right). The station weighed 1,419 lbs. Strange looking vehicles like this one in which science has outdone science fiction," are blazing a trail to the planets.



Tass

TOMORROW

The four-armed monster, in this drawing, called the "Schmoo," is an unmanned repair craft sent out by the wheel-shaped space station in background to render assistance to a nuclear-powered space vehicle in difficulty.



Drawing Lockheed Aircraft Corp.

A concrete scheme of experimentation and designing is born of the free play of intellects. These flights of fancy are becoming a necessary stage in preparatory work that sometimes takes years to complete. The basis of it all is a perfectly comprehensible and natural human quality—man finds it difficult not to yield to the temptation to think ahead of his time.

It would of course be naive to suggest that this one human quality is sufficient explanation of man's urge to get out into the great universe. There are objective causes of a demographic and social nature that are rather more difficult to understand.

One can quite easily imagine the time, a few hundred years from now, when the population of the world will become so dense that each continent will be turned into one big city like Moscow or New York. Man will feel the overcrowding physically so that for him the mastery of considerable areas in outer space will have a practical significance. The future spread of man is bound up with space since he will be unable to confine himself to his own planet, even if, for the time being, he has not realized this. This, too, was one of Tsiolkovsky's ideas.

Long before the physical overcrowding is felt, however, people will begin to feel a spiritual constraint. A surplus of energy within a close-knit community must find an outlet or there will be stagnation and retrogression. Man always stands in need of a goal that mobilizes his spiritual and physical energy. Sooner or later all mankind will unite and there will be no further danger of the nuclear self destruction of civilization.

Then, to a greater degree than now, the single community will have before it a great purpose—the conquest of space, beginning with circumsolar space.

Today's space flights are mere reconnaissance; the means for a thorough study of conditions in space and dangers that await man there have still to be created. The dangers I have in mind are solar flares, lethal radiation, dust clouds, meteoric showers, the effect of long periods of weightlessness on the human organism and other hazards specific to travel beyond the bounds of the earth.

We have still to develop, on the grand scale, ways of studying the planets, their surfaces and their composition, their atmosphere and their radiation and magnetic fields.

Lastly we have still to design spaceships capable of journeys to other planets that may last several years, provide them with ultra-long-distance communications and with navigation instruments, and supply oxygen, food and water for the crew under conditions in which every ounce of weight counts.

To do all this cybernetics will have to be extensively developed, electronic computers and analysers perfected and a "Sun Service" organized that will provide a series of circumsolar automatic satellites to transmit data predicting solar flares, the direction in which radiation streams are being generated, and so on. Space biology and planetology must also be further developed. There will be a need to build observatories in space, artificial inhabited planets from which studies of the universe can be made and which can be used to facilitate space travel.

Even this sketchy programme of space exploration gives some idea of the colossal effort man must make and the expenditure that will be necessary to put it into effect.

Has not the world perhaps begun its invasion of space prematurely? Is not the expenditure of effort and resources inadvisable since it has to be made now, whereas people will live in space in hundreds of years' time? Would it not be more reasonable to create better living conditions everywhere on earth and let space wait its turn...?

In principle, one cannot open the door to a new sphere of activity and then suddenly slam it shut again, not even for the sake of economy. The process works only one way; it is irreversible—if the technical means for space travel exist they cannot remain unused. The exploration of

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Why we are outward bound *(Cont'd)*

space, moreover, is already bringing beneficial results, even at this initial stage.

The implementation of an intricate programme for the design of carrier rockets, automatic space stations and spaceships is promoting the rapid development of the more progressive branches of science and engineering—cybernetics, physics, biology and medicine, radio engineering and the aerodynamics of supersonic velocities. The results of this development also effect ordinary "terrestrial" life because they promote general technical progress and thus better living standards.

Some of the achievements of space engineering have already made their mark in economic and cultural life. Retransmission satellites are used for telecommunications, including television on a global scale. Navigation satellites make sea travel more reliable. Meteorological satellites are reducing errors in forecasting weather conditions in various parts of the world.

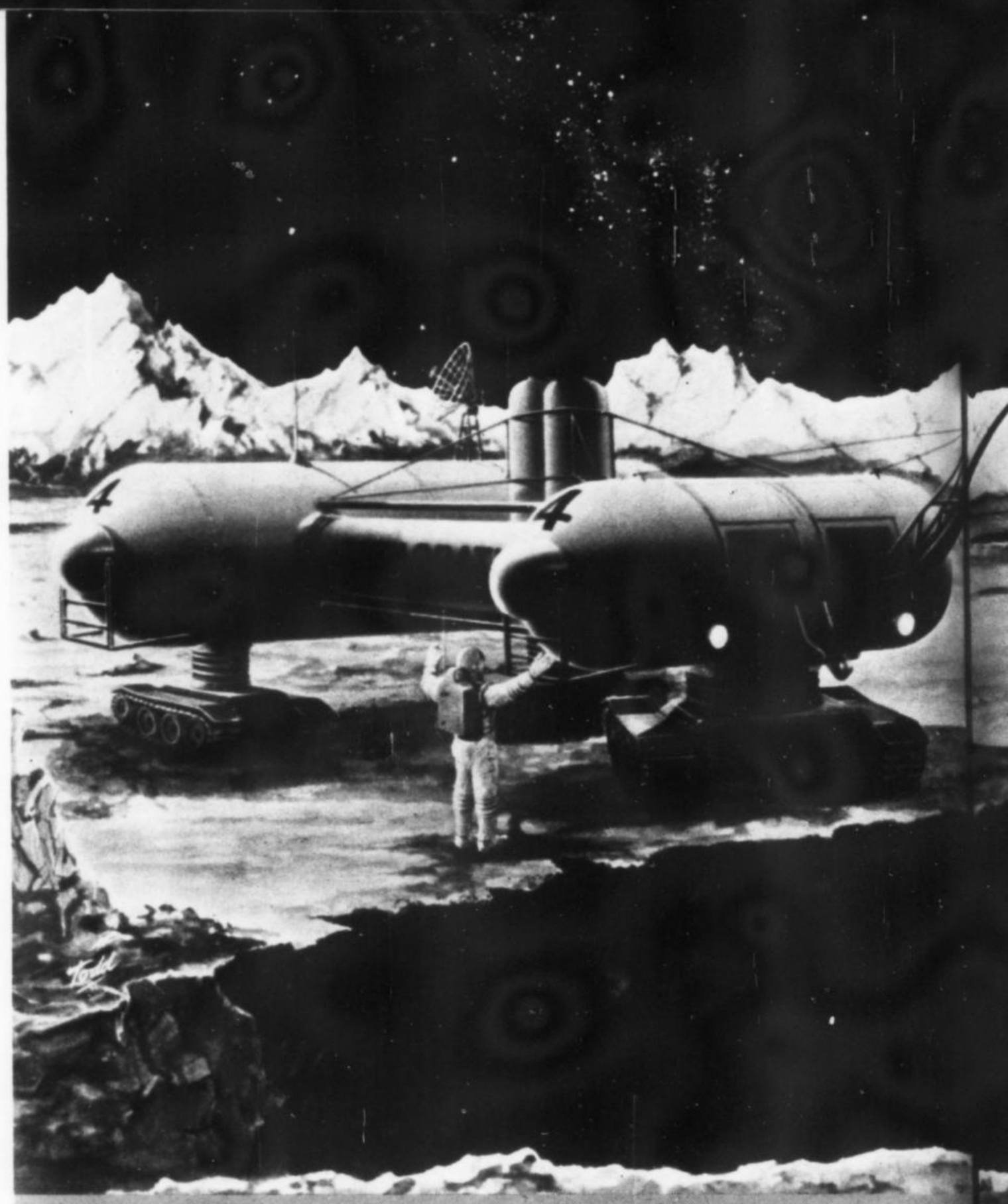
I think it is a mistake to weigh space exploration against man's efforts to improve his living standards. These are different aspects of the totality of human progress and they are not contradictory.

The two "space powers", the U.S.S.R. and the U.S.A., are working separately, independently of each other. Does this have a negative effect on the rate of development and the results of space exploration?

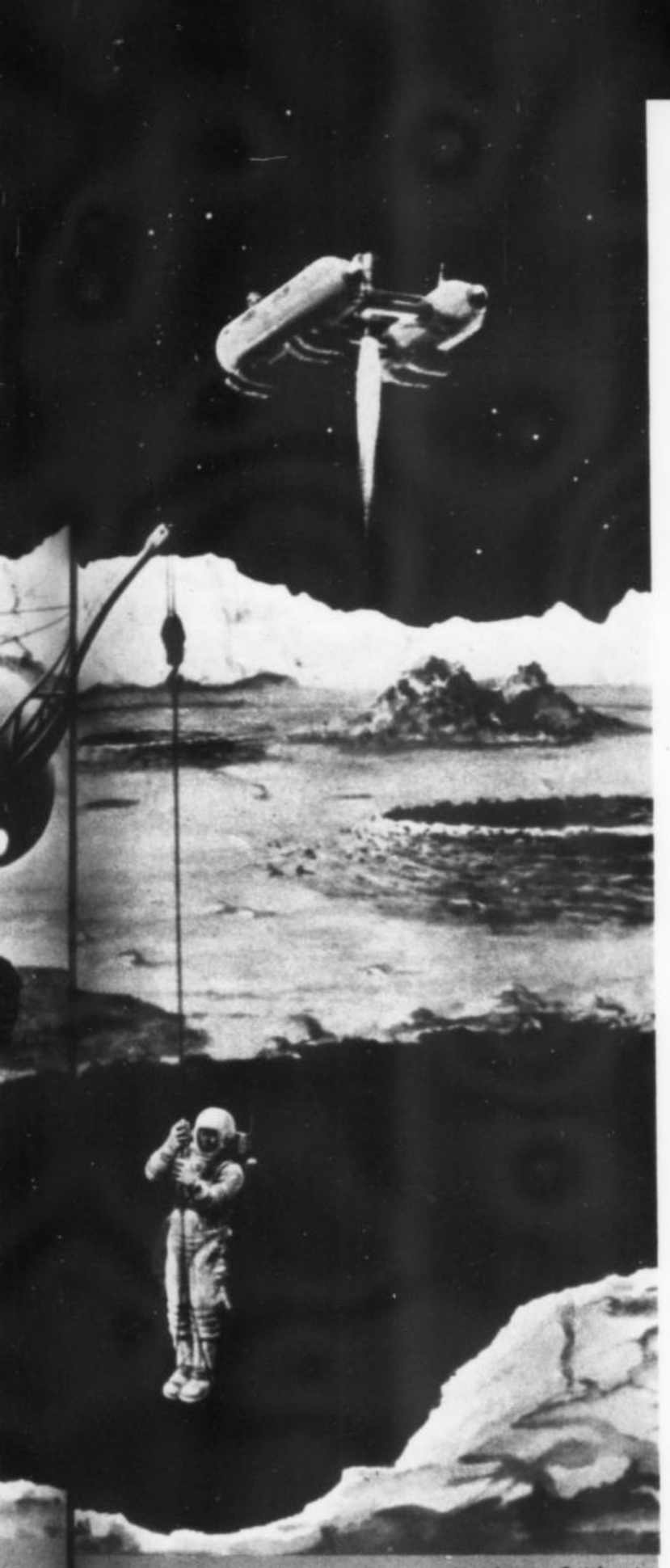
Personally, I think not; I believe that this involuntary rivalry has not, up to now, been a hindrance. When anything new is started, an approach from different angles tends to further its development.

Steps have already been made along the road to co-operation. Work on the U.S. satellite Echo 2 has begun on an international scale. There are also prospects of space collaboration with France. We may expect the next stage in the development of this co-operation to be the exchange of information, the exchange of orders for the manufacture of various installations and a certain degree of specialization.

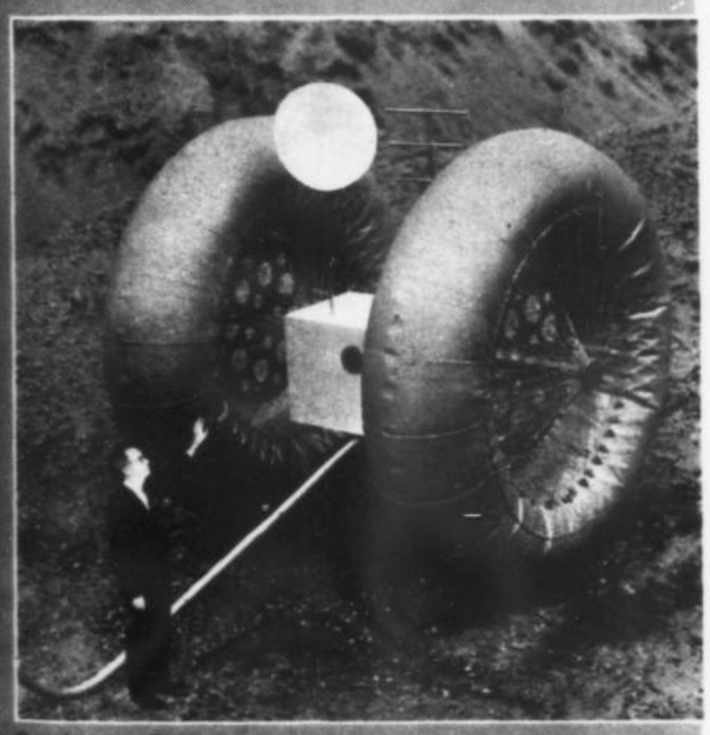
It is quite obvious that as the exploration of space proceeds, sooner or later problems will arise that cannot be solved by any one country but which will require the united efforts of all mankind.



MOON CRAWLER. Capable, sturdy self-contained vehicles will be required for lunar exploration and development. This drawing shows one concept of such a vehicle. Equipped with threepoint caterpillar treads for stability and a rocket system, this hybrid vehicle would be able to crawl or make short flights over moon terrain. It would carry geophysicists, geochemists, geologists and other scientists on long range investigations over the moon's surface.



Drawing Northrop, California



Goodyear, Ohio

MAMMOTH TYRES (above) are a mock-up of those being developed for a U.S. moon vehicle. Though 16 ft. in diameter, each will weigh only 125 lbs.

LUNAR LANDSCAPE. The surface of the moon photographed last February by the Soviet moon probe, Lunar 9, first spacecraft to make a soft lunar touchdown.

LUNAR INTERNATIONAL LABORATORY

by Bruno Friedman

SOMETIME around 1970 a human being will, for the first time in the history of the universe, set foot upon the moon. The visible vehicle that will carry him there will be a rocket. Yet in a very real sense the true thrust will be generated not by burning fuel, but by the surge of science over the centuries.

The truth of this statement is revealed when it is realized that the epochal feat will be synthesized out of major contributions from virtually every branch of modern science (and of engineering, as well): chemistry, physics, electronics, mathematics, medicine, bacteriology, psychology, astronomy, geophysics, metallurgy, and others.

Now let us note—for it is germane to what follows—that science is, above all, international. There is no branch of science that has been developed by a single nation. Rather, every branch of science is the creation of knowledge-seekers, great and obscure, of all nations, each making his contribution over the course of time to erect the total moon-achieving structure.

With science so much the shaper of the achievement, it is most fitting that science will be a great beneficiary of man's installation on the moon. As Dr. Frank Malina states it: "Just about every branch of science will find the moon, with its unique environmental conditions—no atmosphere, a gravity only 1/6th that of earth, very weak or non-existent magnetic field—a great laboratory for a host of experiments and observations essentially impossible to perform on earth. Great progress must inevitably be stimulated."

Dr. Malina speaks as Chairman of the Lunar International Laboratory (LIL) Committee of the International Academy of Astronautics (IAA). And the LIL Committee, composed of distinguished space scientists from several nations, is the embodiment of the awareness that the moon's great potential for science can best be realized if the investigations are conducted as an international venture and in an international laboratory.

The LIL Committee came into being in August 1960, when the concept of a lunar international laboratory was put forward by Dr. Malina at Stockholm during the 11th Congress

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Will the moon disclose a lost record of the universe?

of the International Astronautical Federation (IAF) and was welcomed as a meaningful project by the then newly-formed Academy (1).

The committee has two purposes: to awaken the interest of the world's scientific community at large in the lunar laboratory, and to explore by means of discussions and symposia the various lines of research that can be profitably conducted on the moon. These are generally held at the annual IAF congresses, whose seats are the capitals of the world.

THE committee's efforts have met with considerable success. Its meetings and a discussion panel held at Warsaw in 1964 have produced a broad overall view of lunar science. Now the sciences are being explored in depth at symposia devoted to particular subjects. At the first symposium at Athens in September 1965, the papers presented dealt specifically with lunar geosciences and astronomy and astrophysics. The subjects for the Madrid symposium, in October 1966, are the life sciences and lunar medicine.

That the majority of the papers are presented by experts who are not committee members reveals the widespread response of the international scientific community to the idea of a lunar laboratory.

From these studies will be evolved a sound scientific programme for a laboratory, when the time is ripe for it. When? The committee foresees that this will be sometime in the period 1975-85.

The scientific investigations on the moon may greatly advance our understanding of man, his environment and the universe in which he lives.

The priority subject will be, of course, the moon itself. The foundation work will be done at the national level by the first moon explorers, American and Soviet, perhaps acting in co-operation as the nations do in Antarctica.

The large-scale work of mapping the moon's geographical, geological and geophysical features will be done by circumlunar satellites, some put into orbit even before the first human landings, others after. These highly sophisticated orbiters, using infra-red sensors, radar, radio microwaves, radiation counters and other devices, will not only map the surface, but probe under the surface.

The lunar scientists themselves will make direct observations and experiments to determine the nature of the lunar rocks, the moon's seismic and volcanic activity, its internal temperature and structure.

What is learned about the moon may help answer many questions about our earth. The geological record of the earth's history has been greatly damaged and obscured by the volcanic, seismic, erosive and sedimentary processes to which the crust has been subjected over the 4.5 thousand million years of the earth's existence.

This is much less true of the moon, with no atmosphere, no oceans and a far cooler interior. Reading the geological record of the moon, which is as old as the earth, may reveal much, by analogy, particularly about the earth's formative period, its first one thousand million years.

Moreover, this reading of the moon's early history, taken together with analyses of the remains of meteorites on the lunar surface, will give the scientists valuable clues as to how the solar system itself was formed.

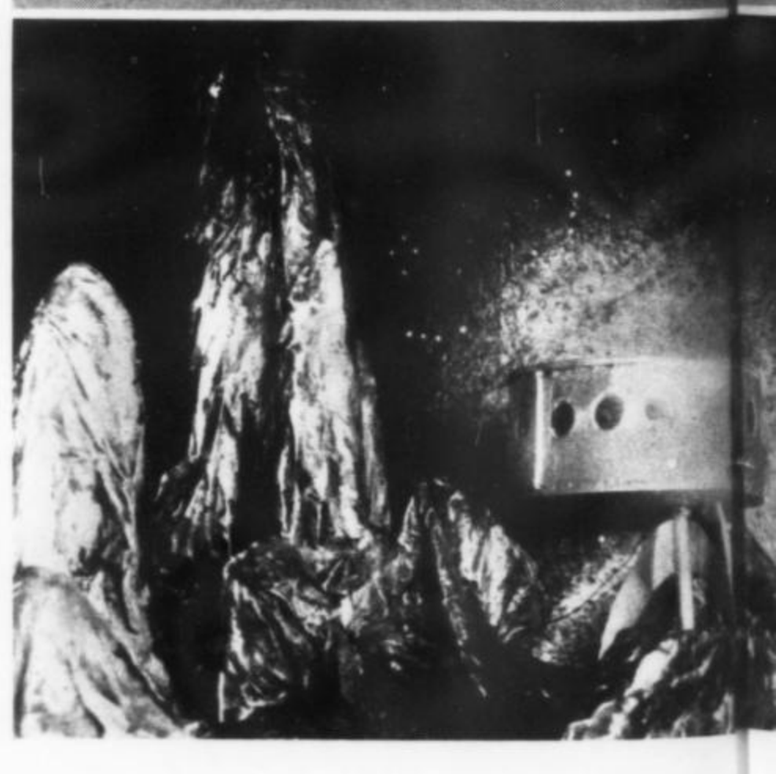
Meteorites are artifacts of the solar system's genesis, relics left over from the age when dispersed matter agglomerated to form the planets and their moons. These invaluable information carriers from the past reach the earth in frustratingly limited numbers, for very few survive the fiery passage through the atmosphere. But the moon's surface will be rich with their remains.

CONT'D ON PAGE 34

(1) Its present roster includes such luminaries of the space sciences as: M. Florkin of Belgium; N. Boneff of Bulgaria; A. Dollfus and L. Malavard of France; H. Oberth of the German Federal Republic; F. Zwicky of Switzerland; L.I. Sedov of the U.S.S.R.; A.C. Clarke, Z. Kopal and Sir Bernard Lovell (Vice-Chairman) of the U.K.; and W.H. Pickering, S.F. Singer, L. Spitzer Jr., H. Strughold and H.C. Urey of the U.S.A. Norair Sissakian of the U.S.S.R., was also a member until his death last March.

Heroes & hobbies of the junior astronaut

The conquest of space fascinates young people the world over. Right, Polish youngsters perch beneath pictures of U.S. and Soviet astronauts—their real-life heroes. Far right, reverie beneath a large-scale model of a lunar landscape. Right, young Soviet space enthusiast displays a model interplanetary station he has designed and made; it will join spacecraft and installations on the model of a future inhabited planet (below) made by other members of a junior astronauts' club in the U.S.S.R.



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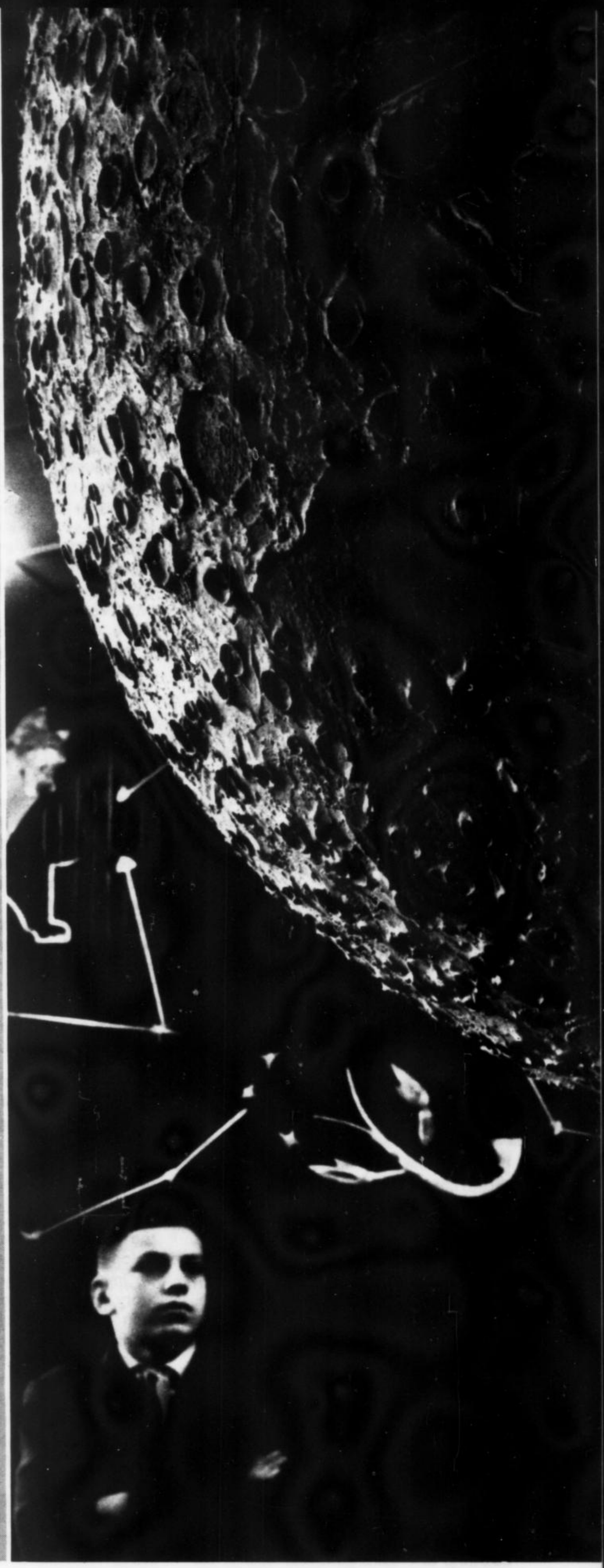

Photos © APN - L. Gromov

A superb new window on the far reaches of space

Valuable indications as to how life evolved on earth may also be found in the lunar surface. That any life forms, or even remains of life forms, will be discovered is doubtful, given the moon's harsh conditions. Yet the lunar scientists may find carbon compounds, produced by natural chemical reactions, which represent intermediate stages in the formation of the first primitive carbon-based living molecules from which all life on earth developed. This would be a resounding discovery.

There is even a remote possibility, points out Prof. H. Florkin of the University of Liege, that primitive life forms or their remains may be found in lunar micro-environments, where the conditions are far less severe than in the gross environment. Such micro-environments may be, for example, deep pits in craters, the interiors of porous rocks or some metres down in the lunar surface layer.

To the new insights that lunar science may provide about the solar system, earth and life, add those that may be gained about the origins and formation of the great universe itself, because the moon will be such a superb observatory for both optical and radio astronomy.

On earth, the atmosphere greatly limits the passage of light waves and radio waves. Moreover, man himself is a considerable impediment, producing enormous quantities of artificial light and interfering radio waves from all forms of electronic equipment.

Astronomy on the moon will gain greatly from the absence of these disadvantages, as well as from specific lunar advantages, such as a far slower rotation period, enabling astronomical instruments to follow their targets over a much longer period of time.

Lunar telescopes, optical and radio, will be able to probe much farther out into the reaches of space, will be able to "see" heavenly objects far dimmer than can be now seen from earth, will be able to resolve much finer details of these objects, will be able to "see" much better into the interior of our Milky Way, a typical spiral galaxy.

From the new information gained—as, for example, by the accurate counting of distant galaxies—it may be possible for cosmologists to decide between two current conflicting hypotheses about the origins of our universe —or to reject both and propose a better one.

The moon will also be an outstanding meteorological observatory, helping to raise weather prediction to new levels of accuracy, it was noted by Prof. K.Y. Kondratiev and co-workers of the University of Leningrad in a paper presented at the Athens LIL symposium. Telescopic observations from the moon will follow the large-scale movements of clouds and air masses in the earth's atmosphere. Their big view will complement the smaller-range, more detailed observations made by a system of meteorological satellites orbiting the earth.

ALL the above is a very incomplete catalogue of science on the moon. In addition, observations, presently impossible from earth, will be made on cosmic rays and on the nuclear particles that fill interplanetary space; experiments in considerable variety will be made in chemistry and physics in the lunar vacuum and in plant and animal biology in rigorous lunar conditions. Important advances in all these fields cannot fail to result.

Moreover, much will be learned about man himself: about his physiology, his psychology and his sociological relationships in the high-stress lunar environment. The LIL scientists themselves will be the guinea pigs.

For, as Prof. C. Stark Draper of the Massachusetts Institute of Technology has emphasized, humans will be in short supply in the lunar laboratory for a long time because of the high costs of placing men and equipment there. Much of the data gathering will be done by compact automatic sensors. These data, after condensation in the laboratory's lightweight computers, will be telemetered to co-operating research centres and universities on earth for analysis.

Which points up a question: How will a lunar laboratory be created, organized and managed as a co-operative international activity?

The LIL Committee cannot deal with this question, for this is a matter that governments must resolve. Quite possibly, however, a suggested scientific programme evolved out of the committee's work will be helpful when the intergovernmental deliberations regarding a laboratory begin.

The committee feels that possibly the lunar international laboratory could be established under the auspices of an existing international organization, such as the U.N. or Unesco. And an indication of Unesco's awakening interest in the matter is the fact that it is contributing funds to enable scientists to attend the 1966 Madrid LIL symposium.

Certainly these bodies, the U.N. and Unesco, have long been interested in the establishment of international scientific centres.

A few such centres have indeed been created: CERN (European Centre for Nuclear Research) at Geneva and the International Computation Centre at Rome, both founded through Unesco initiative, though they are not Unesco bodies; also, there are the United Institute of Nuclear Research at Dubna, U.S.S.R. (the Eastern European equivalent of CERN), the European Launcher Development Organization (ELDO) and the European Space Research Organization (ESRO).

So the nations can get together. Moreover, the problems of establishing a lunar centre, a lunar international laboratory, may be much reduced by comparison with those which have blocked the founding of terrestial scientific centres, by the moon's remoteness—thus reducing the conflicts of national self-interest—and by its powerful appeal as a human adventure. So the world's states may have a stronger *will* to bring a laboratory of this kind into being.

The foundations for a lunar international laboratory may well have been laid on December 13, 1963, when the General Assembly of the United Nations unanimously approved a Declaration of the Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space. The first principle states:

"The exploration and use of outer space shall be carried on for the benefit and in the interests of all mankind."

SPACE FLIGHT AND THE RULE OF LAW

Continued from page 18

satellites, fragments) circulating in outer space and liable, sooner or later, to fall back to earth, the danger of their colliding either with other similar objects or with space vehicles traversing the atmosphere will increase as time goes on.

The 1963 Declaration already proclaims, as a general principle, that each state which launches or originates the launching of an object into outer space and each state from whose territory or installations an object is launched, is internationally liable for damage to a foreign state or to persons or property within its borders by such object or its parts, whether the damage is caused on the earth, in the air, or in outer space.

This provision in general terms needs to be followed up by an international convention such as that which the Committee on the Peaceful Uses of Outer Space is at present engaged in drafting, on the basis of proposals submitted by Belgium, Hungary and the United States. The convention will need to define what is meant by "damage" (material damage, moral damage, financial loss and so on). The extent of liability will also have to be specified. Should provision be made for exemption or attenuation? Is liability to be limited? How is liability to be shared out in the event of joint enterprises by several states?

In the case of launchings carried out by an international organization, who will be responsible for damage caused? The Declaration of 1963 simply states that "responsibility for compliance with the principles set forth in this Declaration shall be borne by the international organization and by the states participating in it." Is provision to be made for joint responsibility? Procedures to be followed to obtain compensation for damages will also have to be drawn up.

In addition to these two important legal questions, now being considered, the Declaration mentions various others for which international agreements will doubtless be necessary. There is, for instance, the principle whereby states shall conduct their activities in outer space with due regard for the corresponding interests of other states. This provision was included on account of certain experiments in the past which gave rise to some agitation amongst the users of space, in particular astronomers.

The Declaration outlines an arrangement whereby if a state believes that an activity or experiment in space which it or its citizens plan to carry out might interfere with the peaceful exploration and use of space by other states, it should first consult them. Conversely, such consultations could also be requested by states if they considered that certain activities proposed by other states might interfere with the peaceful exploration and use of space. However, this text lacks precision, and lays down no specific procedure for such consultations or for following them up.

THE broader principle of ensuring that certain experiments cause no harm to mankind as a whole has been the subject of detailed studies both at the Institute of International Law in Brussels and at the David Davies Memorial Institute of International Studies in London. Both have stressed the danger that might result from any modifications of the earth or the celestial bodies, their atmosphere or space itself, by the introduction of elements liable to upset the existing equilibrium, such as by changing the climate or meteorological conditions of specific regions.

The British institute has drawn up various regulations designed to provide against and sanction any such activities. Here again, a convention is called for; also a convention to prevent biological, radiological or chemical contamination of outer space and the celestial bodies by vehicles from the earth and vice-versa.

With the installation, in the near future, of manned scientific stations first on the moon and subsequently on other celestial bodies, the legal status of such stations, will naturally have to be considered. In view of the general principles proclaimed in the Declaration of 1963 the installation of such stations will not, of course, constitute grounds for national appropriation of the moon or celestial bodies, or even of the particular area on which such stations are located.

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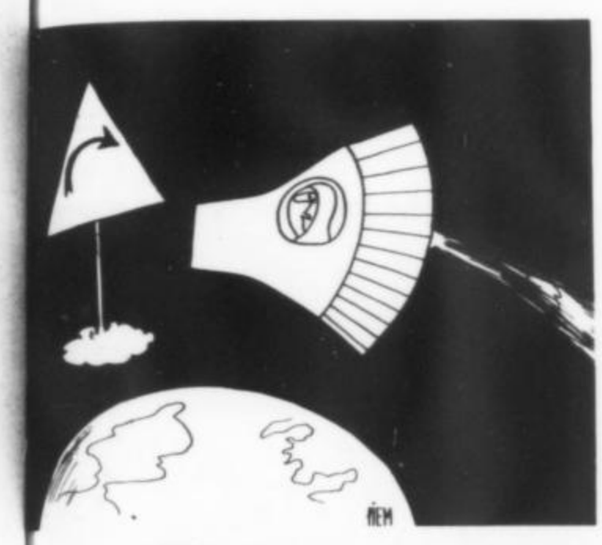
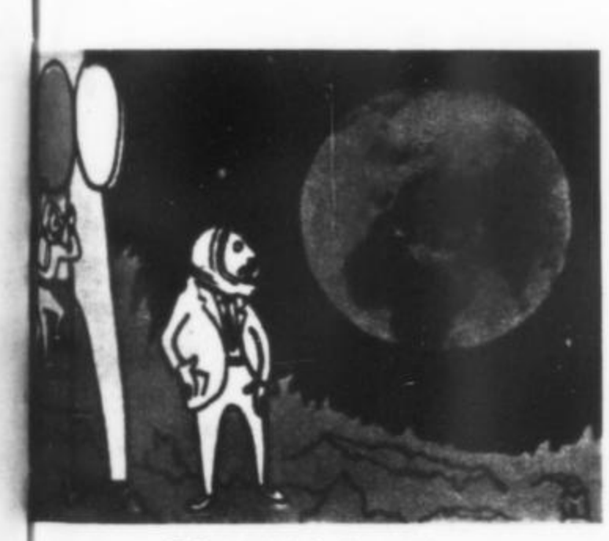


— Who put me into orbit the wrong way round?

© Piem



— What did I do with my space-pilot's licence?

Drawings © M. Schulmeister "Soviet Union"

— Look! the Martian canals are simply abstract paintings.

From the Unesco Newsroom...

An alphabet is born

Six major West African languages have now been given a unified alphabet. Meeting at Bamako, Mali, under Unesco's auspices (see the Unesco Courier, March 1966) an international group of linguists has produced a simple alphabet that enables all the sounds in six languages—the Mandingo languages, Songhay-Jerma, Tamashek, Hausa, Kanuri and Fulani—to be accurately represented. The alphabet's six languages, in roman letters, will be basically identical, and Fulani, Hausa, Tamashek and Songhay-Jerma will require only eight new letters. Six linguistic groups spread over seven nations now have alphabets that should enable them to transcribe an immense heritage of oral literature, and governments have national languages for adult literacy teaching and primary education.

World's longest radio antenna

A steel and aluminium cable almost two miles long has been stretched over a fjord in northern Norway. It is an antenna —the longest in the world—and one of the links in the international Omega navigational trial system which so far comprises transmitters in Trinidad, Hawaii, and Forestport, New York.

Space is 'in'

What is uppermost in the minds of Americans today? Visitors to the American Library Association's computerized library exhibit at the New York World's Fair gave a clear indication that it is travel in space. Visitors were able to put questions to a computer which responded by producing reading lists at five educational levels, or essays in English or four languages on 75 current interest topics. "Travel in Space" led in both the number of reading lists and essays requested.

Helping deaf children to speak

A combined headphone-microphone unit designed in the United Kingdom can help partially deaf children to speak. It can be used to magnify the volume of sound without distortion so that even a deaf child can listen to its own first efforts at forming sounds and words. In the classroom the children's headphones can be connected to a common amplifier set before the teacher, whose voice can then be heard by the children.

Colourful highways

A laboratory in the Federal Republic of Germany has perfected a method of permanently colouring road surfaces. Experiments now being conducted indicate that colour-coded roads might eventually replace the forest of warning signs that distract almost as much as they instruct the driver on high-speed freeways.

Electricity from a coconut

Coconut milk, as well as the juice from sugar cane, yams and certain fruits, can be used to produce electricity. The technique perfected by a group of U.S. scientists, involves the use of bacteria (aeromonas formicans) which turn the coconut milk into formic acid. This is an electrochemical fuel from which a battery can draw electric current. The system, known as the biochemical fuel cell, has already been used to power a transistor radio.

World population atlas

Soviet scholars have begun the compilation of a "World Population Atlas". Maps showing the migration of populations, their distribution and location, social and cultural features will provide a picture of the varied character of the world population today. The atlas will also contain maps showing the settlement of nomads, urbanization, the rise and growth of new metropolises and the connexion between the spread of the population and irrigation developments.

Unesco - Dominique Roger

An international group of jazz artists donated their services for a concert given at Unesco headquarters recently for the benefit of the world campaign against illiteracy. Among them were the trios of Art Simmons, Michel Sardaby, Ron Jefferson and Errol Parker; instrumentalists Don Jetter, Hal Singer, Nathan Davis (above, on left) and Glen Ragland; Singer Jenny Gordee, Ruble Blakey, who introduced the artists, and Ted Easton's Jazz Band. Proceeds from the concert, which was organized by the Jazz Club of Unesco's Staff Association, will be used to help finance literacy projects in various parts of the world.

Space flight and the rule of law *(Cont'd)*

The David Davies Memorial Institute of International Studies has suggested that these stations should be placed as soon as possible under United Nations control, but that the state which has established, or permitted its nationals to establish such a station should retain jurisdiction over all persons inhabiting it, and over such of the surrounding area as has to be traversed for the use and upkeep of the station.

In the event of two stations belonging to different states being installed in close proximity on a celestial body, it would be essential to define their respective fields of competence and also to take certain other measures designed in particular to prevent interferences in their radio communications.

The status of lunar or planetary stations, and also of space platforms, now presents an urgent legal problem for jurists to take into consideration.

Other legal problems either have arisen or will arise as a result of the recent development of communications by satellite, a new system which clearly holds great promise not only as a means for supplementing and facilitating communications by the traditional methods, but also for the rapid spreading of education and development of cultural exchanges. Such communications will, however, require

Tracing fresh water 'leaks' in the ocean

A new method of locating underground water is being used by the U.S. Geological Survey. Infra-red photographic detectors, sensitive to heat, are mounted on aircraft and are used to scan the coastlines of Puerto Rico and the Virgin Islands in search of much needed fresh water sources. Since the fresh water is either warmer or cooler than the ocean water, the heat detectors can clearly distinguish it flowing into the ocean from underground water-bearing rocks. Scientists then trace these "leaks" to their source, which can eventually be tapped.

Roadbuilding around the world

The Soviet Union has begun to construct a 620-mile (1,000 km.) freeway that will link Moscow and Wolgograd (formerly Stalingrad). A 1,300-mile (2,090 km.) road is to be built in India from Dehra Dun to Amingaon through the states of Uttar Pradesh, Bihar, West Bengal and Assam, paralleling the Ganges River for most of the way. Work will begin this year on a three-lane, one mile (1.6 km.) tunnel under the River Elbe, by-passing Hamburg, Federal Republic of Germany. Some 1,200-miles (1,930 km.) of road were built in Inner Mongolia in 1964.

School for community leaders

A college of a new kind has been founded in Palermo, Sicily, by a group of Italian, Swedish and British specialists. The Sicilian Institute for the Training of Development Workers, as it is called, will train unionists, co-operative members, farmers, teachers and other potential local leaders to take greater responsibility and initiative in the development of their own communities.

Level of Caspian falling

Between 1930 and 1965 the depth of the Caspian, the world's largest inland sea, dropped by 2.5 metres (8 ft.) and is expected to fall a further metre by 1976. Soviet scientists say this is due in part to the warming up of the Caspian basin which has reduced the flow of rivers, but the construction of large reservoirs has also contributed. The drop has doubled the need for dredging in ports and canals and has caused a decline in fish catches. The oceanography committee of the Soviet Academy of Sciences is studying several schemes to halt the decline.

Martian laboratory

A chamber reproducing the climate and atmosphere of the planet Mars has been developed at the Microbiology Institute of the U.S.S.R. Academy of Sciences to study the behaviour of bacteria. It automatically reproduces (under an atmospheric pressure one-hundredth of that on earth) the changes that take place in a Martian day, and temperatures varying between —60 degrees and + 30 Centigrade.

Flashes...

■ *Jupiter, the largest planet of our solar system, radiates two and a half times as much heat as it receives from the sun, report astronomers at the University of Arizona.*

■ *A new teleprinter developed in the United Kingdom can transmit 1,250 words a minute—16 times faster than conventional teleprinters.*

■ *About 750,000 seafarers are employed on the world's foreign-going ships, but only 1 % of them are women reports WHO in a world-wide study on the health of mariners.*

■ *A new National Park, the third in France, is being created in the Pyrenees. Covering 125,000 acres, it adjoins the Spanish frontier south of Lourdes.*

■ *More than 10,000 foreign students are enrolled in Austria's universities and technical colleges and comprise about 20 % of the country's total student population.*

BOOKSHELF

■ **Art Treasures of the United Nations**

By Jacob Baal-Teshuva. On the art that embellishes U.N. Headquarters. Thomas Yoseloff, New York and London, 1964 ($7.50).

■ **Management of Wild Mammals in Captivity**

By Lee S. Crandall, General Curator Emeritus, New York Zoological Park. The University of Chicago Press, Chicago and London ($13.50).

■ **The Black Ship Scroll**

By Oliver Statler. An account of Commodore Perry's expedition to Japan in 1854, based on contemporay records and Japanese scroll paintings in full colour. Charles E. Tuttle Company, Rutland, Vermont, U.S.A., 1964 ($.5.00).

■ **The Housewarming and other selected writings**

By Rabindranath Tagore. A Signet Classic (paperback), The New American Library, New York and Toronto (75 c.); The New English Library Ltd., London, 1965.

■ **The Arabs**

By E.C. Hodgkin. A new volume in The Modern World series. Oxford University Press, London, 1966 (paperback; 7/6).

■ **The Birth of the Gods: the origin of primitive beliefs**

By Guy E. Swanson. University of Michigan Press, Ann Arbor, U.S.A.; Ambassador Books Ltd, Toronto, Canada, 1960 ($5.95).

■ **The Population Dilemma**

A picture of population trends and prospects in the world presented by eleven authorities and edited by Philip M. Hauser. (The American Assembly, Columbia University series). Prentice-Hall Inc., Englewood Cliffs, N.J., U.S.A., 1963 (Paperbound, $1.95; clothbound, $3.95).

the elaboration of new laws, especially when it becomes possible for radio and television signals transmitted from some part of the earth to be received direct, via a satellite, at any other point on the earth.

Even at the present stage in the development of telecommunications, numerous legal difficulties have arisen, for which a solutions must be found. Some of these difficulties were discussed recently at a meeting of experts on the use of space communications by the mass media, held at Unesco Headquarters, in December 1965. They are due, for instance, to such things as differences in the laws on the use of satellites in transmitter and receiver countries, differences in libel laws, variations in copyright laws according to whether or not countries are parties to the copyright conventions, and whether or not advertising is allowed in radio programmes.

There will be a need for special regulations governing the composition of programmes for universal transmission, so as to avoid infringing certain regulations in force. The Preamble to the Declaration of December 13, 1963 recalls that a General Assembly resolution of November 3, 1947, which condemned propaganda designed or likely to provoke or encourage any threat to the peace or act of aggression, is applicable to outer space.

As the science of astronautics achieves new successes in the conquest of space, fresh legal problems will arise, in addition to those outlined above, calling for solution by wide international co-operation.

Letters to the Editor

'UNESCO, WHAT IT IS...'

Sir,

Why not send a pamphlet such as "Unesco, what it is, what it does, how it works" to each new subscriber along with the first number of the Unesco Courier? This would give your new readers a clear understanding of Unesco's aims and show them its wide range of activities, and they would get even greater benefit from reading the Courier.

G. Thevenot
Châteaudun, France

An excellent suggestion which has been adopted. Arrangements are being made for a copy of "Unesco, what it is, what it does, how it works", in English, French or Spanish, to accompany the acknowledgement of each new subscription—Editor.

SPACE-AGE READING

Sir,

We are interested to see that your January 1966 issue contains an article, "Messages to the Stars", by Dr. D.M.A. Mercer, one of a series of papers delivered at the Science Fiction session of the Southampton meeting of the British Association for the Advancement of Science last year.

We should be obliged if you would find space to insert a note drawing your readers' attention to the fact that this paper and the other three papers in the Science Fiction session are available in "The Advancement of Science", the Journal of the British Association (Vol. 22, No. 98, August 1965, price 5/-). The titles of the other three papers are Travel in Space and Time, Problems of Alien Biology, and Alien Sociology.

J.M. Robertson
Editor, The Advancement of Science
3 Sanctuary Buildings
20 Great Smith Street, London S.W. 1.

WOMEN IN SCIENCE AND TECHNOLOGY

Sir,

In connexion with International Co-operation Year we have just been celebrating, I would like to call your attention to an activity of international co-operation: to help promote the education of women in scientific-technological fields where women represent a valuable, yet relatively untapped source, and where there is a need for them to supplement manpower.

In 1964, the First International Conference of Women Engineers and Scientists was held in New York and brought together over 500 women engineers and scientists from 35 countries and all 50 states of the U.S.A., who shared experiences, plans and aspirations with each other. They now look forward to the second such international conference, to be held in England in July 1967, one of whose themes will be "Enough for Everyone—the application of technology to world food problems." (The conference secretary is Mrs I.H. Hardwich, AEI Power Group Research Laboratory, Trafford Park, Manchester 17, England.)

I have been a Unesco Courier subscriber for many years and have contributed toward a better understanding of the U.N. and especially of Unesco's immense programmes throughout the world by putting on a local radio information programme and city-wide displays to familiarize the people of my community. I also initiated in Connecticut the adoption of a Unesco Gift Coupon Project for Ecuador. Now I would like to see publicity being given to the fact that there is an urgent need and a place for women, properly qualified and interested, in science and technology all over the world.

Vera H. Zepler
Chairman, Connecticut Section,
Society of Women Engineers, U.S.A.

YOUTH OF GABON GREET UNESCO

Sir,

Members of the Central Club of Gabonese School Activities for Unesco (Lycée Léon Mba, Libreville) and the young people of Gabon as a whole were deeply stirred by the New Year message to youth from the Director-General of Unesco published in your February issue. As general-secretary of the Unesco club, I wish to thank the Director-General and to ask him to accept the good wishes of the youth of Gabon for 1966. If there is anyone to whom the world's young people should send their greetings, that person is certainly the Director-General of Unesco, who is helping them and working for them through the organization he directs.

Joseph Boussamba-Koucka
Libreville, Gabon

VOLUNTEERS OF VALUE

Sir,

Your issue on Youth (July-August 1965) contained an enthusiastic article on the work of young volunteers. It might influence people who hold opposite views and sometimes discuss the idea of stopping all recruitment of young volunteers workers if they heard the story of the two volunteers I know most about.

Tony Sleight and Steve Cuthbert, came from the United Nations Association of Great Britain and Northern Ireland in 1964-65, to help me at the Ramallah Men Teacher Training Centre, an institution for Palestine refugees set up in Jordan by the United Nations Relief and Works Agency (UNRWA).

From the start they showed ability and willingness to do any job. Tony Sleight, a graduate in chemistry, had a real talent for experimental work, and took charge of the chemistry laboratory. Steve Cuthbert, a physics graduate, took over the physics laboratory. They worked hard to keep their laboratories in running order, repaired instruments and built teaching devices.

In the first semester we were short of one science instructor, so our volunteers became teachers and despite the language barrier were able to give students valuable guidance in experimental work. In the second semester we were able to make greater use of portable science kits with which teachers in schools without laboratories can demonstrate some 500 experiments in physics, chemistry and biology. This inspired our volunteers to produce a 50-page English-Arabic science dictionary and a 25-page glossary. To finish this before leaving Jordan they often worked long after school hours. They also helped to plan a summer in-service training course and took part in it too.

It is easy to criticize and to quote cases where volunteers have created nothing. However, providing they are the right kind of young people and if they have a chance to work creatively and are made to see that we need their help, we have in them a powerful force to reinforce the efforts of the developing countries.

Karl Slemming
Ramallah, Jordan

Mr Slemming is a mathematics and science specialist loaned to UNRWA by the Danish Refugee Council—Editor.

BUILDING PEACE

Sir,

I consider the Unesco Courier to be one of the most significant publications of our times, and I loan my copy and quote from it amongst my friends and business associates, and at my Rotary and sports clubs.

Many people despair of the United Nations, but they see only the distrust and bickering of the political section. If despite its undoubted weaknesses in this area, the United Nations can keep us out of major war which would inevitably escalate into total destruction of our civilization, there is some reason to hope that the other branches—WHO, UNICEF, Unesco, etc.—will set in motion an avalanche of enlightenment which will overwhelm those whose fingers itch on the trigger.

Leslie J.V. Henry
North Rockhampton
Australia

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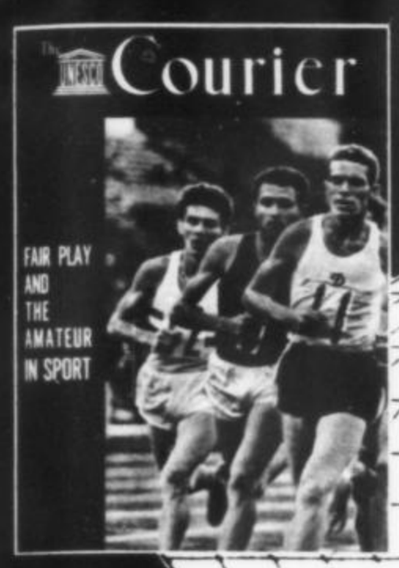
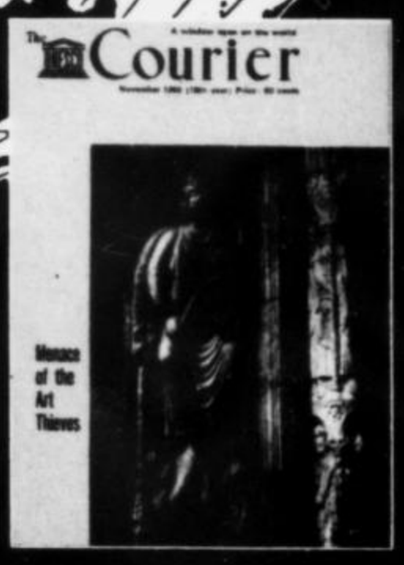
A WORLD OF DIFFERENCE...

The Unesco Courier





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UNITED STATES

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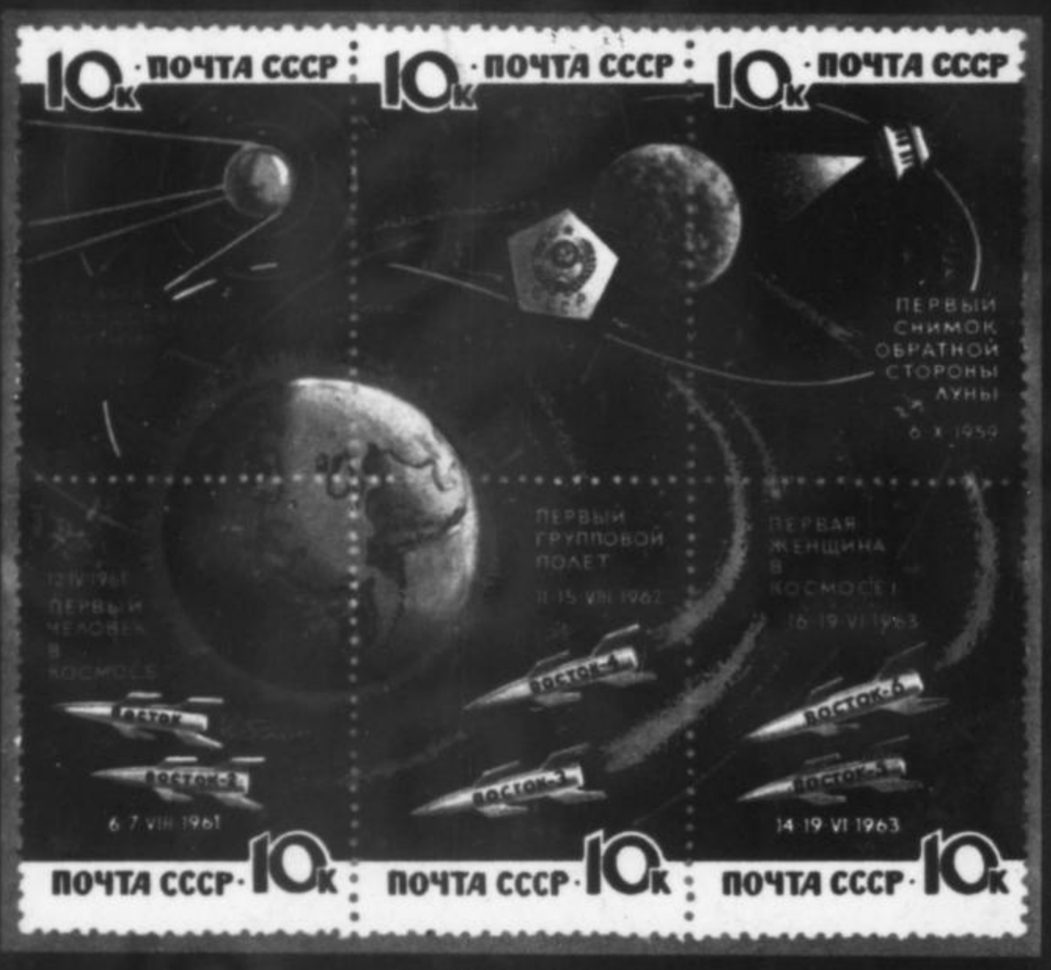

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